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NUTRITIONAL STATUS ASSESSMENT OF MARINES BEFORE AND AFTER THE INSTALLATION OF THE "MULTI-RESTAURANT" FOOD SERVICE SYSTEM AT THE TWENTYNINE PALMS MARINE CORPS BASE, CALIFORNIA

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Report prepared by the USDA/ARS, Western Human Nutrition Research Center, Presidio of San Francisco, California 94129, for Letterman Army Institute of Research, in fulfillment of the Memorandum of Understanding signed April 4, 1980 between SEA-HN and DoD.

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Nutritional Status Assessment of Marines Before and After the Installation of the "Multi-Restaurant" Food Service System at the Twentynine Palms Marine Corps Base, California--Kretsch et al

Human Subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Reg 50-25 on the use of volunteers in research.

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The Twentynine Palms Marine Corps Base study was designed to evaluate the effects of instituting a new "multi-restaurant" food service system on the nutritional health of enlisted male and female Marines. Dietary, biochemical, anthropometric, and socio-demographic data were collected from RIK and COMRATS personnel before and after the food service modifications.

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ABSTRACT

The Twentynine Palms Marine Corps Base study was designed to evaluate the effects of instituting a new "multi-restaurant" food service system on the nutritional health of enlisted male and female Marines. Dietary, biochemical, anthropometric, and sociodemographic data were collected from Rations-in-Kind (RIK) and Commuted Rations (COMRATS) personnel before and after the food service modifications.

Male RIK personnel consumed 50% of their meals and female RIK personnel 20% of theirs at the dining halls. These percentages were the same before and after the "multi-restaurant" food service system installation. The percentage of daily calories consumed by RIK personnel at the dining halls did not change significantly with the new food service system. There was a significant increase for all groups in the percentage of daily calories from outside restaurants and vendors and from snacks after food service modifications.

Overall, the general nutritional status of male personnel at Twentynine Palms Marine Corps Base was satisfactory with the exception of vitamin A. More nutritional concerns were evident for the female RIK personnel. The new feeding system improved the daily iron density intakes of all personnel and improved the daily thiamin and niacin density intakes of RIK females. However, the new system had a negative nutritional impact on RIK personnel vitamin A status as judged by dietary intake and serum vitamin A. The dining hall meals consumed after the food service modifications had lower vitamin A density contents. The mean percentage of daily calories contributed by fat remained at 40%. Recommendations were made to alter the "multi-restaurant" menus to include more high vitamin A content foods and foods which would assist the Marine in lowering daily percent calories from fat; to encourage increased use of dining facilities by women Marines; and to develop a Marine Nutrition Education and Awareness Program to help Marines prevent and correct their own nutrition problems.

PREFACE

A project of this scope cannot be conducted without a good amount of assistance and cooperation from a large number of individuals. The authors wish to acknowledge the excellent support received from COL W. J. Hallisey, Chief of Staff, and CPT W. Robinson, Base Food Service Officer, during the Twentynine Palms Marine Corps Base study. In addition, we would like to thank the enlisted personnel who participated in the study, their personnel officiers, and the unit commanders whose support and cooperation made the study a success.

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The Marine Corps Base at Twentynine Palms is located in the California desert, about 50 miles northeast of Palm Springs. The base is a Marine air-ground-combat training center. This is the largest Marine Corps installation in the world. Troop activities at the base include communications and electronics school students and permanent personnel, headquarters and service personnel, air-ground-combat troop trainees and trainers, and combat support personnel. While the majority of the base is uninhabited desert which is primarily used for tactical field exercises, this study concerned itself with the "main base" area where all the troops are garrisoned.

During March 1974, the United States Marine Corps (USMC) submitted to the Department of Defense Food Research, Development, Testing and Engineering Program a request for analysis of the Twentynine Palms (TNP), California, Marine Corps' food service system. The Operations Research/Systems Analysis Office of the United States Army Natick Research and Development Command was responsible for the basic requirements of the request as submitted by USMC, while the Department of Nutrition, Letterman Army Institute of Research (LAIR) was responsible for evaluating the nutritional impact of the food service system changes on enlisted personnel. The purpose of the project was to define, develop, and evaluate significant improvements to the existing Marine Corps garrison food service system as represented by food service operations at the Marine Corps Base, Twentynine Palms, CA. In particular, the primary objective of the study was to increase consumer attendance and acceptance at the enlisted dining facilities while remaining within existing cost and operational constraints. The resulting "multi-restaurant" concept consisted of eight outlets, three serving 12-day cycle A-ration type menus, three serving specialty type meals (steak, Italian, and Barbecue) and two offering short order menus such as hamburgers, hot dogs, french fries, etc. (See Figure 1). Each dining hall had its own unique decor (theme) to complement the menu offered. The specialty and short-order dining facilities provided relatively constant menus which contained high preference items. This complex of eight food outlets was supplemented by a mobile food service unit which served short order type meals at remote areas such as the Rifle Range during lunch and in the barracks area in the later evening periods.

The nutritional impact evaluation of the food service system changes was conducted by LAIR in two phases. The first phase was conducted in March 1977 before food service modifications. The second phase was conducted in October-November, 1978, after food service changes had been operational for about four months. This provided before and after comparisons of the nutrient consumption of the enlisted Marines. During both study phases, temperate environmental conditions existed. Reports covering the impact of the "multi-restaurant" system on dining hall attendance and operational concerns, and on the nutrient intake of meals consumed in the dining halls have already been published (1,2). This report presents the dietary intake, biochemical nutritional status, and some socio-anthropometric data on Marine enlisted personnel before and after the food service system modifications.

METHODS

Subject Selection. At the time the studies were conducted, the base population was approximately 7,000 personnel not including civilians and military dependents. Within the Marine Corps enlisted population, seven separate groups with different eating habits were identified. The differences among the groups thought to influence eating habits were: (a) rations status (Ration-in-Kind vs. Commuted Rations), (b) the assigned unit (it was assumed that the different duties performed by units would affect activity level and hence, caloric consumption), (c) marital status (married vs. single), and (d) men vs. women. The groups studied and the subject selection criteria utilized are shown in Table 1. Utilizing the selection criteria, unit personnel officers randomly selected 55 subjects per group from their personnel rosters. The subjects were briefed as to the purpose of the study and they signed consent and privacy act statements before participating in the study.

Rations-in-Kind (RIK) and Commuted Rations (COMRATS) are two systems by which the Armed Services provide food to military personnel. RIK allows for three meals per day served by a military dining facility, and the food (whether consumed or not) is considered as a portion of the service member's salary. COMRATS provides money (for food purchase) in lieu of food to military personnel. To qualify for COMRATS, personnel must receive permission or be granted permission by regulation. Since the policy at TNP restricted those Marines receiving COMRATS from eating in the dining halls, except under special circumstances, any changes in the food service primarily impacted RIK personnel.

RIK-males made up about 65% of the total base population whereas RIK-females comprised only about 3% of the base population at the time of the studies. Baseline data on COMRATS personnel were gathered to serve as control data.

Due to the non-availability of sufficient numbers of single men receiving COMRATS, this group contained less than 40 subjects in phase I and was not studied in phase II. It was also difficult to obtain adequate numbers of women Marines to participate in the study and thus less than 50 women per phase were studied. In reading this report, the number of personnel studied for dietary intake evaluation differs from the number studied for biochemical status evaluation. This is because some personnel did not participate in the biochemical evaluation.

Demographic and Anthropometric Data. Selected anthropometric and demographic data were collected during both phases of the study. Demographic data collected included age, race, rank, months in service, months at the present post, housing quarters, and regularity of nutrient supplement consumption. Height and body weight were measured in both study phases. In order to assess caloric balance in phase II, each individual's body weight was measured at the begining and again at the the conclusion of the study period (about a four-week interval). Skinfold thickness was assessed in both phases. In phase I, right and left scapula and triceps measurements were taken. In phase II, right and left triceps, biceps, subscapula, and suprailiac skinfolds were measured. Skinfold measurements were made by using a Lange skinfold calipers and were conducted by the same individual in both phases. Each subject was evaluated against Navy weight-for-height standards (3) and percent body fat was estimated utilizing the Chinn and Allen equation (4) and/or the Durnin and Womserley equation (5). The Chinn and Allen equation is only suitable for estimating percent body fat in men. In phase I, the skinfold sites measured on women were not sufficient to utilize the Durnin-Womserley equation and thus percent body fat for phase I women is not included in this report.

Dietary Intake Data. Individual food consumption data were collected utilizing a dietary diary-interview technique developed by investigators at LAIR (6). Fourteen consecutive days of data were collected in phase I and seven consecutive days in phase II. (After analysis of the nutrient intake data collected during phase I (7), it was apparent that seven rather than fourteen days of dietary diary information would be more accurate as well as more cost effective.) At the initial dietary interview, each subject was randomly assigned to an interviewer. The interviewer had been trained in the LAIR dietary diary-interview technique. The interviewer met once with each subject before commencement of data collection and then at 3 to 4 day intervals during the data collection period. At the first interview, the subjects were instructed in the procedures for recording daily food and beverage consumption on pocket-size diary cards. Guidance was also provided on how to record the TIME (hour), the SOURCE (dining hall, home, restaurant or vendor) and the QUANTITY (household measures, package weight, etc.) of food and beverages consumed. Intake of water, salt, and spices were not recorded. The importance of recording consumption information as soon as possible after eating was emphasized. At all subsequent interviews, subjects returned completed cards to the interviewer for verification of portion size estimate, for clarification of unusual food items, and for assignment of each food item as a component of either a meal or snack. If an individual indicated consumption of nutrient supplement(s), he/she was asked to bring in the nutrient supplement bottle or label so the nutrient content of each tablet or capsule could be recorded by the interviewer.

Each interviewer coded for computer processing the dietary data of his/her assigned subjects. Each interviewer also verified the correctness of the coded data. Some data coding occurred at TNP so questions could be answered while still on site. Each food item was assigned a food identification number from the LAIR Nutrient Factor File (NFF) and the quantity of the food or beverage was converted from household measures to the equivalent gram weight. The NFF is a computerized file of food nutrient composition values obtained from the U.S. Department of Agriculture, other published literature, and food manufacturers. When necessary, recipes were estimated for complex food items, such as casseroles, and nutrients computed from nutrient values of the ingredients. The time of day and where the food item was consumed (source) were also coded. The sources were defined as follows:

1. Dining Hall - Refers only to the enlisted dining halls at the Marine Corps Base.

2. Home - Refers to foods prepared and consumed at home or foods prepared at home and consumed elsewhere such as a bag lunch, picnic, etc.

3. Restaurant - Refers to commercial food outlets which provide seating for on site food consumption.

4. Vendor - Refers to commercial food outlets where seating is not provided, grocery stores providing ready-to-eat food, vending machines, and mobile food carts.

Seven days of food consumption information from each phase were utilized for calculation of nutrient intake data. For phase I, the first seven of the fourteen days collected were utilized. Nutrient supplement consumption has not been included in the total daily nutrient intake or nutrient density intake data presented in this report. However, the nutrient supplement intake was combined with food and beverage nutrient intake for evaluation of dietary-biochemical status relationships.

Average nutrient intake and average nutrient density were computed for each subject by each source, by meal or snack, and on a daily basis. A 2 X 3 factor analysis of covariance (2 study phases by 3 groups) was used to test for significant effects ($P<0.05$) of phase and group on mean total daily nutrient intakes. The covariates used were age and body weight. Average group values for anthropometric data, demographic data, meals consumed, daily nutrient density intakes, and dining hall meal nutrient density were tested for significant effects of phase or group with a 2 X 3 factor analysis of variance (ANOVA). Those variables found to be significant by analysis of covariance or variance for group were then tested with the Student Newman Keuls multiple comparisons test for significant differences between groups. In the report which follows, differences are stipulated as significant if $P>0.05$.

Shown in Table 2 are the military dietary allowances (MDA) and the nutrient density allowances which were used to evaluate the calculated nutrient intakes. The former are the nutritional standards established for the Armed Services (8), whereas the latter are the same allowances but expressed on a per 1,000 kilocalorie basis.

The MDA are based on the U.S. Recommended Dietary Allowances (9) but adapted to meet the needs of healthy military personnel of average height and weight, between the ages of 17-25 years, who are moderately active, and living in a temperate environment. The recommendations contained in the MDA differ from those in the U.S. Recommended Dietary Allowances (RDA) for only three nutrients:

energy, protein, and ascorbic acid. The reasons for the variations are explained in the report of Schnakenberg et al (6). Energy allowances in the RDA are established to meet the mean requirements of a normally distributed population. All other nutrients for which an allowance has been set, have a margin of safety above the mean requirement included in the allowance. In assessing the nutritional adequacy of dietary intakes, if the quantity of a nutrient consumed falls below the MDA for a particular group, some individuals in the group can be assumed to be at nutritional risk. When the proportion of individuals in the group with low intakes is large, the risk of nutritional deficiency is increased. In this report, nutrient intakes for all nutrients, except energy, were termed adequate if consumption equalled or exceeded the standard, marginal if consumption was between 70% and 100% of the standard, and low if consumption was less than 70% of the standard.

The nutrient density allowances are often utilized as an index of nutritional quality. Use of nutrient density allowances in evaluation of dietary intakes have certain limitations. Requirements for various nutrients and, therefore, allowances which are based upon those requirements, are not always related to energy intake. For example, vitamin C, vitamin A, sodium, and potassium are essential even with a zero caloric intake. Additionally, individuals with low energy requirements will have higher nutrient density requirements than those with high energy eeds. In the absence of knowledge on the range of a population's energy requirements, nutrient density allowances can be based on the mean energy requirement, but application of the standard is most suitable to population evaluations.

The latest revision of the U.S. Recommended Dietary Allowances (10) included estimated safe and adequate daily dietary intakes for selected vitamins and minerals (electrolytes, some trace elements, vitamin K, biotin and pantothenic acid). For these selected nutrients there is less information on which to base allowances and thus, recommended intake ranges were established. Table 3 presents these ranges. In addition, food composition data are not available for all nutrients for all foods. Therefore, calculated nutrient intakes are less accurate for some nutrients. In this report, those nutrients of lesser accuracy are indicated. However, it is valuable to include the data on the nutrients of lesser accuracy because it is useful to know if a military allowance is met in spite of inadequate nutrient composition data.

Biochemical Nutritional Status Data. The subjects in a fasting state arrived at the examination laboratory in the morning at 0430 hours for the blood collection. The blood samples were drawn in Vacutainer[R] tubes; one tube contained heparin and the other contained EDTA as anti-coagulants for the preparation of whole blood and plasma. A third tube was used without an anti-coagulant for the preparation of serum samples. Hemoglobin (11) and hematocrit (12) determinations were performed immediately at Twentynine Palms. The samples were then processed to prepare serum, plasma, erythrocyte, and whole blood preparations and air-shipped frozen to San Francisco for analysis.

On the morning of the blood collections, the first urine voided was collected from each subject following a 6 to 8 hour fast. Specific gravity (13) and osmolality (14) were determined at Twentynine Palms on the urine samples. The urine samples were then aliquoted, preserved according to analytical requirements, frozen, and air-shipped to San Francisco for analysis.

The serum samples were analyzed for levels of total proteins (15) albumin (16), globulins (17), protein electrophoretic patterns (17),vitamin C (18), total lipids (19), total cholesterol (20, 21), triglycerides (22), calcium (23), phosphorus (24), magnesium, copper, and zinc (25), ferritin (26-28), and iron and total iron binding capacity (TIBC) (29). The serum iron (transferrin) saturation was derived from the latter two indices. Folacin (folic acid) levels were determined in erythrocytes (red cells) and serum by microbiological assay procedures (30-31). Vitamin B-12 (30), vitamin A (32), and carotene (32) levels were also measured in the serum samples. Serum high density lipoprotein (HDL) cholesterol was estimated with the use of a precipitation procedure (20, 21, 33). The low density lipoprotein (LDL) cholesterol levels represent derived values (20, 21, 33, 34). The cholesterol risk factor is derived from the ratio of the serum total cholesterol and serum HDL cholesterol values (20, 21, 33, 34). Erythrocyte glutamate-oxaloacetate transaminase (EGOT) activity (35), erythrocyte glutamate-oxaloacetate transaminase-pyridoxal phosphate (EGOT-PLP) stimulation (35), erythrocyte transketolase-thiamin pyrophosphate (ETK-TPP) stimulation (36), and erythrocyte glutathione reductase-flavin adenine dinucleotide (EGSSR-FAD) stimulation (37) were measured in the erythrocyte preparations.

The urine specimens collected were analyzed for thiamin (30), riboflavin (30), free vitamin B_6 (30), phosphorus (24), sodium

(38),potassium (38), magnesium (25), calcium (23), nitrogen (39), urea (40), and creatinine (41). The urinary values were expressed in terms of creatinine excretion (42).

The guidelines (42) used to evaluate the biochemical data are summarized in Tables 37A-37C.

RESULTS AND DISCUSSION

Demographic and Meal Consumption Characteristics. Presented in Table 4, are demographic and meal consumption characteristics for the study groups. The male and female RIK populations were not significantly different from each other for age, months in service, and months at present post. They also did not have significant differences for these characteristics between study phases. The COMRATS group differed significantly from the RIK group for these characteristics. The COMRATS group in phase II was significantly older and had been at the present post and in the service significantly longer than the group in phase I. The rank breakdown by group was essentially the same in both phases except the RIK-females group had a greater percentage of lower ranking females in phase II. There was a significant drop in the average number of meals consumed per day for COMRATS-males and RIK-females. About two daily meals were consumed by all groups in both study phases. Percent average dining hall utilization by all groups did not change significantly between study phases. RIK-men continued to consume about half of their meals at the dining hall and RIK-females about 20% of their meals. The evaluation report of the "multi-restaurant" food service system by the Natick group (1) cited a dining hall utilization increase of 29.7% over the former food sevice system. The discrepancy in dining hall utilization figures might be explained by the fact that the Natick group collected attendance data over a 3-month period (Oct-Dec 1978) whereas the data for this report were collected over a 3-week period (during Oct and Nov 1978). Dining hall utilization was low for COMRATS-males because they were not allowed access to the dining halls except by special permission.

Table 5 presents the percentage of RIK personnel consuming weekday and weekend day meals. The Communications and Electronics School and the Headquarters and Service Batallion (C&E/H&S) males as well as the RIK-females had more personnel consuming an average of one or less weekday meal during phase II than during phase I. The force troops (FT/FSSG) males average weekday meal consumption remained the same in both phases. During both phases, about 30%

of each group, except RIK-females in phase II, consumed 3 meals per weekday and about 40-50% of each group consumed 2 meals per weekday. Those personnel who reported an average of zero meals per day consumed their food through snacks. Less than 15% of the RIK population consumed 3 meals per day on weekends during both study phases. For all groups, an increased number of personnel consumed one meal per weekend day during phase II.

Table 6 indicates the percentage of RIK groups consuming weekday and weekend dining hall meals. The percentage of force troops males consuming 3 meals per day in the dining hall increased about 10% in phase II. The proportion of C&E/H&S males consuming zero meals per weekday in the dining hall increased 15% in phase II. RIK-females weekday dining hall consumption patterns remained about the same; about 50% consuming zero dining hall meals per weekday, about 30% consuming 1 dining hall meal per weekday, and only about 12-13% consuming 2 dining hall meals per weekday. As would be expected, dining hall meal consumption on weekends was considerably less than during the weekdays. Overall, weekend dining hall utilization was less in phase II than in phase I.

Anthropometric Data. Tables 7, 8, and 9 present the anthropometric characteristics for the groups studied. Except for the RIK females, no significant differences were found between study phases for height, weight, estimated percent body fat (Chinn and Allen equation), and skinfold thickness. RIK-females showed a significant increase in the mean right subscapula skinfold thickness in phase II. The significant difference in mean estimated percent body fat between RIK and COMRATS males reflects the difference in mean age between the groups. All groups had a greater percentage of overweight individuals in 1978 than in 1977 (an increase of 5% for RIK-males, of about 24% for RIK-females, and of about 8% for COMRATS-males). During phase II, the average weight change over the study period was negligible for the groups studied. This indicates that most personnel consumed adequate calories for weight maintenance in phase II. The slightly negative average weight change for RIK-females during phase II may reflect individuals who were dieting since nearly 32% of the RIK-females exceeded the weight for height standards.

Presented in Tables 8 and 9 are the estimated percentages of body fat of the Marines. As expected, estimated percent body fat increased with age regardless of the equation utilized. The Chinn and Allen equation yielded a 2-5% lower estimate of body fat for males than did the Durnin and Womserley equation. Utilizing the Chinn and Allen formula, the percent body fat in all age groupings is lower than had been found in previous studies of the military male population (43).

Total Daily Nutrient Intake. Presented in Table 10 are the nutrient supplement consumption patterns for the groups studied. Multi-vitamin tablets were the most frequently consumed form of supplementation. About 25% of the COMRATS-married group took multi-vitamins in both phases. About 16% of the RIK-females consumed multivitamins in phase I and about 24% in phase II. RIK-male multi-vitamin consumption decreased slightly between study phases; 11% of the group in phase I and 8% in phase II. The percentage of each group taking multi-mineral, vitamin B-complex, vitamin C, and vitamin E supplements was greater in phase II than in phase I. The RIK-female iron supplement consumption increased from 8% of the group in phase I to 19% in phase II.

Presented in Tables 11A through 13B are the average daily nutrient intakes from food and beverages for each of the groups studied. Nutrient supplement consumption has not been included in the total nutrient intake or nutrient density intake data. Results from the analysis of covariance of these data are shown in Tables 14A and 14B. Statistically significant differences were found between phase I and phase II for energy, protein, fat, carbohydrate, cholesterol, animal protein, animal fat, plant fat, calcium, phosphorus, magnesium, potassium, iron, zinc, copper, riboflavin, vitamin B-6, folic acid, and pantothenic acid. Group status (RIK-males, RIK-females, or COMRATS-males) had a significant effect on the consumption of all nutrients except fish fat. Age had a significant effect on the consumption of energy, carbohydrate, calcium, phosphorus, magnesium, sodium, manganese, riboflavin and niacin. Body weight did not have a significant effect on the consumption of any of the nutrients.

1. Energy. RIK-females and COMRATS-males had a 250-300 kcal decrease in mean energy intake between phases I and II. The RIK-males of the force troops units reported essentially the same energy consumption, 2800 kcal, in phase II as in phase I. RIK-males from the C&E/H&S units had about a 450 kcal decrease in phase II. In all groups the mean reported energy intake was 425 to 750 kcal below the military standard. As noted earlier in this report, mean body weight change measured in phase II did not change significantly for any of the groups. Therefore, it can be

assumed that energy intake was adequate for most individuals. Whether the reported caloric intakes are accurate can not be assumed as there is a certain amount of error inherent in dietary intake methodology. However, if one compares the reported energy intakes of the RIK groups with those collected from individuals of the same sex and age group during the HANES, 1971-74, study (see Table 15) it can be noted that the reported caloric intakes are similar.

2. Protein. RIK and COMRATS male groups had similar mean protein intakes for both phases. These protein intakes were equivalant to or greater than the miltary standard. RIK-females had mean protein intakes less than the military standard for both phases of the study. RIK-males and females had about the same level of protein intake as reported in the HANES, 1971-74, survey.

3. Fat. Except for RIK-males from the C&E/H&S units, no significant differences were found between study phases for daily mean fat intake for any of the male groups. RIK-females had a significant decrease in mean daily fat intake in phase II.

4. Cholesterol. A significant drop in cholesterol consumption was found for all the groups, except RIK force troops personnel, between phase I and phase II. However, due to the fact that the COMRATS groups also exhibited a drop in cholesterol intake, it could be deduced that the food service system changes were not solely responsible for the reduction. The cholesterol intake of the RIK personnel was at about the same level as reported for individuals of the same sex and age group during the HANES 1971-74 study (Table 15).

5. Carbohydrate, Crude Fiber, and Alcohol. Except for the RIK-males from the C&E/H&S units, all other groups did not show a significant change between phases for daily mean carbohydrate, crude fiber, or alcohol consumption. The average crude fiber intake of the American population is between 3 to 7 grams per day. All groups studied consumed between 2.5 to 4.0 grams per day.

6. Minerals. Mean calcium and phosphorus intakes exceeded the MDA for both phases of the study for RIK and COMRATS-males. RIK-females and RIK-males from the C&E/H&S units had a significant decrease in mean daily calcium consumption in phase II. In phase II, the RIK-female calcium intake fell below the

MDA. The RIK-female phosphorus intake, however, was adequate during both phases. Mean magnesium intake was below the MDA for all male and female groups during phase I and II. In addition, the mean magnesium consumption for all groups decreased significantly between phase I and II. It should be remembered that magnesium food content was not available for all food items and thus, the calculated daily values may be lower than actually consumed.

During both study phases, mean sodium consumption for male groups was at the top of or exceeded the safe and adequate range set forth in the 1980 RDA (9). It should be noted that the calculated sodium values do not include salt added during cooking or at the table and therefore, are lower than the level of actual consumption. The RIK-female mean sodium consumption for both phases fell in the middle of the RDA's range. Mean potassium intake for all groups fell within the estimated safe and adequate range set by the RDA. Except for the RIK-males from the C&E/H&S units, mean sodium and potassium intakes did not change significantly between study phases.

The mean daily iron intake for male and female groups was less than the MDA during both study phases. Except for RIK-males from the force troops units, no significant change in mean iron intake was found for any of the groups between study phases. The mean iron intake of RIK-males from the force troops units increased significantly between phase I and phase II. The males' MDA for iron is set at 18 mg per day in order to ensure that 17 and 18 year old males, who are still in the growth phase, receive an adequate daily intake of iron. For men 19 years or older, a daily intake of 10 mg is sufficient. About 9% of the men in the RIK-groups and less than 3% of the men in the COMRATS-groups were 17 or 18 years old, and therefore for all practical purposes the mean intakes for these groups were adequate.

In evaluation of the zinc, copper, and manganese mean daily intakes, it should be remembered that complete food nutrient information is not available for these nutrients. Mean zinc intake for the male groups either exceeded or was slightly below the MDA during both study phases. Therefore, taking into consideration the lack of food nutrient data, it is probable that zinc intakes were adequate for all the men. The RIK and COMRATS men from C&E/H&S units had a significant drop in their mean zinc intake between study phases. RIK-females had mean zinc intakes at

75% and 50% of the MDA for phase I and phase II, respectively. This decrease in zinc consumption for the females was significant. Copper and manganese mean intakes for all groups were less than the RDA estimated safe and adequate ranges. For all groups except the RIK-males, no significant changes in mean intakes were observed for copper or manganese between study phases. RIK-males had a significant decrease in copper consumption between study phases.

7. Vitamins. No significant change occurred between phases of the study in the mean intake of vitamin A, vitamin C, thiamin, riboflavin and niacin for all but one of the RIK and COMRATS male groups. However, the mean intakes of vitamin A and thiamin were less than the military standard for most of the male groups. RIK-males from the C&E/H&S units and RIK-females had a significant decrease in the mean riboflavin intake between study phases. RIK-females had mean intakes less than the MDA in both phases for vitamin A, thiamin, and niacin.

Food nutrient analysis information is limited for vitamins B-6, folic acid, B-12, and pantothenic acid and therefore the mean daily calculated values should be evaluated with this in mind. Vitamin B-6 mean intakes were less than the MDA for all groups. Except for COMRATS-males from the C&E/H&S units, no significant changes in mean vitamin B-6 intake occurred for any of the groups between phases. Mean folic acid intakes were less than the military standards for all groups for both study phases. All groups, except for RIK-males from the force troops units, had a significant decrease in mean folic acid intake between phase I and II. Mean vitamin B-12 intakes exceeded the military standards during both study phases for all male groups. Vitamin B-12 intakes decreased significantly between phase I and II for RIK-males from the C&E/H&S units. Mean vitamin B-12 intake for the RIK-females was 75% of the military standard in phase II. Mean pantothenic acid intakes were within the RDA estimated safe and adequate range for RIK-males during both study phases and for COMRATS-males during phase I. RIK-males from the C&E/H&S units, COMRATS-males, and RIK-females all had a significant decrease in mean pantothenic acid consumption between phase I and phase II.

8. Sucrose and Total Sugar. Presented in Table 16 is the average daily sucrose and total sugar consumption. (Food analysis data are limited for sucrose and sugars.) Mean sucrose and total sugar consumption remained about the same between phases. RIK-females consumed about 15% of their total daily calories from

sucrose and male groups consumed about 10% of theirs from sucrose. RIK-males and RIK-females had about a 4% increase between phase I and II in mean percent of daily calories from sugar. RIK-females consumed between 20-25% of their daily kcal in the form of sugar. RIK-males consumed between 16% to 20% of their daily calories from sugar. COMRATS-males' mean percent of calories from sugar remained about 15% in both phases.

Average Daily Caloric Composition and Caloric Sources. Table 17 presents the mean percentage of the daily calories provided by protein, fat, carbohydrate and alcohol for each of the groups studied. Table 18 presents the results of an analysis of variance for these variables. No significant differences were found between study phases for any of the variables. RIK groups consumed about 14% of their calories from protein and COMRATS-males consumed about 16% of their calories from protein. All groups consumed between 38% to 40% of their daily calories from fat. The MDA recommends that less than 40% of the daily calories be contributed by fat. Male groups received about 40% of their calories from carbohydrate whereas female Marines consumed about 44% of theirs from carbohydrates. Alcohol made up about 6.5% of the daily calories for RIK-males, about 3% for RIK-females, and about 4% for COMRATS-males.

Figure 2 shows the percentage of the average daily energy intake (mean $\pm$ standard deviation) from snacks for the groups studied. All groups had a significant increase of about 5% in energy derived from snacks in phase II. RIK personnel consumed about 20% of their daily energy from snacks in phase I and about 25% in phase II.

Figure 3 presents the percentage of daily calories (mean $\pm$ standard deviation) by source (dining halls, home, restaurants, or vendors). There was a significant increase in the percentage of calories consumed from restaurants and vendors during phase II for all groups. This increase was accompanied by a significant decrease in calories consumed at home. The percentage of daily calories consumed from the dining halls did not change significantly between phase I and II for any of the groups studied. RIK-males received about 50% and RIK-females about 20% of their daily calories from the dining hall during both phases.

Daily Nutrient Density Intake. Tables 19, 20 and 21 present the average daily nutrient density intakes for RIK-males, RIK-females, and COMRATS-males, respectively. Table 22 indicates the results of a 2 X 3 analysis of variance of the nutrient density variables for the groups studied. There was a significant difference between phases of the study for calcium, magnesium, iron, copper,niacin, vitamin B-6, folic acid and pantothenic acid nutrient densities.

RIK-males mean daily nutrient density intakes were less than the MDA (expressed on a per thousand calorie basis) for magnesium, vitamin A, and folic acid. RIK-female mean nutrient density intakes were less than the standard for magnesium, iron, zinc, vitamin A, vitamin B-6, and folic acid for both phases and for vitamin B-12 for phase II. COMRATS-males' mean nutrient density intakes were less than the standard for magnesium and folic acid for both phases. COMRATS-males vitamin B-6 nutrient density was only slightly below the standard for both phases.

For all groups there was a significant increase in iron density and decrease in folic acid density in phase II. Pantothenic acid density decreased significantly between phases for the male groups and niacin density increased significantly between phases for RIK-females and COMRATS-males. A significant decrease for copper density occurred between phases for RIK-males and a significant increase in manganese density for COMRATS-males.

Evaluation of Total Daily Nutrient Intakes and Daily Nutrient Density Intake. The mean nutrient intake value can mask the fact that a substantial portion of individuals within a group may have nutrient intakes far below or above the nutritional standard. Examination of the distribution of low, marginal and adequate nutrient intakes within a population better identifies the nutritional adequacy of the group's diet. Figures 4A through 12C present the percentage of each population consuming low, marginal or adequate daily nutrient intakes and daily nutrient density intakes. The evaluations are presented for those nutrients which had complete food nutrient composition data.

1. Protein. In phase II, the percentage of the population consuming low daily protein intakes increased about 10% within each group. However, the daily protein density intake distribution was slightly improved for all groups in phase II.

2. Minerals. The daily calcium intake and calcium density intake distributions for the RIK-males was about the same for both phases. The percentage of RIK-females receiving low daily calcium and calcium density intakes increased about 12% in phase II.

Forty percent of the RIK-females were consuming low daily calcium intakes during phase II. The percentage of the COMRATS-males consuming low daily calcium intakes increased during phase II but the calcium density intake distribution remained about the same as in phase I.

Average daily phosphorus intakes were adequate for the majority of all three groups. Average daily phosphorus density intakes were adequate for the 98-100% of all groups in both phases.

Average daily iron intake distributions remained about the same for the male groups during phase II; adequate for more than 80% of the population. Although RIK-females showed a slight improvement in the distribution of daily iron intakes during phase II, about 60% of the women were still consuming low average daily iron intakes. Considerable improvement in average iron density intake distribution occurred in phase II for all groups. The RIK-female group had about 70% of the population consuming low daily iron density intakes during phase I whereas only 30% fell into this category during phase II.

3. Vitamins. In phase II, the percentage of each group consuming low average daily vitamin A intakes increased. This increase was particularly marked for the RIK-female group. In phase I, 60% of the female group consumed low average daily vitamin A intakes whereas in phase II this percentage increased to about 95%. Low daily vitamin A density intakes increased from 40% to 45% for RIK-males and from 55% to 80% for RIK-females from phase I to phase II. COMRATS-male vitamin A density intake distribution remained about the same between phases with about 25% of the group consuming low density intakes.

In phase II, low vitamin C average daily intakes increased slightly for the male groups but markedly for the female group. In phase I about 20% of the females had low average daily vitamin C intakes whereas in phase II this percentage doubled. Low vitamin C density intakes increased slightly for all groups in phase II. Approximately 10% of the male groups and 25% of the female group had low vitamin C density intakes during phase II.

The percentage of RIK personnel consuming low daily thiamin intakes remained about the same during both phases; about 30% of the RIK-males and about 40% of the RIK-females. The percentage of the COMRATS-males consuming low daily thiamin intakes doubled from

20% to 40% between phases. On a thiamin density basis, however, less than 10% of all groups had low daily thiamin density intakes. The thiamin requirement is dependent on caloric consumption and thus thiamin density evaluations are a better indicator of dietary thiamin status than the total daily intake evaluations.

The percentage of RIK-males consuming low average daily riboflavin intakes increased slightly in phase II; 10% in phase I and 15% in phase II. The percentage of RIK-females with low average daily riboflavin intakes increased from 20% in phase I to about 42% in phase II. Similarly, the percentage of COMRATS-males with low average daily riboflavin intakes increased from about 8% in phase I to about 24% in phase II. On a nutrient density basis, the distribution of riboflavin intakes of the male groups remained about the same in both phases but the female group's distribution of riboflavin intakes changed slightly (5% had low riboflavin density intakes in phase I and about 13% in phase II).

The average daily niacin intake distributions remained about the same between phases for all groups. About 30% of the females had low daily niacin intakes in both phases whereas less than 15% of the males had low daily niacin intakes in both phases. On a nutrient density basis, the riboflavin intake distributions remained about the same for male groups and improved for the RIK-female group.

Evaluation of Average Nutrient Density per Dining Hall Meal Consumed. Figures 13 through 21 present the percentage of RIK-males and RIK-females consuming low, marginal, or adequate nutrient density intakes per average dining hall meal consumed. Protein density per average dining hall meal consumed improved slightly for RIK males and females in phase II. Calcium density intake distributions remained about the same in both phases for RIK-males whereas the RIK-females showed a slight increase in low and marginal intakes in phase II. The average dining hall meal consumed provided adequate phosphorus density intakes for 100% of the RIK males and females studied during both phases. Marked improvement in iron density intakes occurred in phase II for RIK males and females. RIK-females had 80% of the group consuming low iron density dining hall meals in phase I but only 30% in phase II. None of the females consumed adequate iron density dining hall meals in either phase. The average vitamin A density per dining hall meal consumed decreased in phase II for RIK-males and females. About 85% of the females in phase II in contrast to 60% in phase I consumed low vitamin A density meals. About 40% of the

RIK-males in both phases consumed low density vitamin A meals. The percentage of RIK-males consuming low thiamin density dining hall meals remained about the same in both phases of the study (about 8%). RIK-females, however, showed substantial improvement in their dining hall meal thiamin density intakes in phase II. The percentage of RIK-males and females consuming low or marginal vitamin C density dining hall meals increased in phase II. The distribution of dining hall meal riboflavin density intakes for RIK-males and females remained about the same in both phases. The distribution of dining hall meal niacin density intakes remained about the same between phases for RIK-males but changed markedly for RIK-females. The percentage of RIK-females consuming low or marginal niacin density dining hall meals decreased in phase II.

Biochemical Nutritional Status Data. The results of the biochemical measurements for the male personnel studied are presented in Tables 23-29B while those for female personnel are presented in Tables 30-36B. Guidelines used to evaluate the biochemical measurements are shown in Tables 37A-37C. Iron status in the male personnel appeared satisfactory based on the observed hemoglobin and hematocrit values. Only an occasional low value was observed, principally in the COMRATS married personnel (Table 23). More sensitive measurements of iron status, such as serum ferritin and iron levels and serum total iron binding capacity (TIBC) revealed a somewhat higher incidence of subjects with a risk of iron deficiency (Table 26). Serum ferritin levels, a sensitive measurement of iron stores, indicated, however, a low incidence of male personnel with inadequate iron reserves. Little difference in results existed between Phase I and Phase II of the study. Folacin (folic acid) and vitamin B-12, factors also associated with anemia, were measured in blood specimens (Tables 23 and 26). In all instances, vitamin B-12 status was acceptable. In the case of folacin, however, low serum and red cell folacin levels were encountered in significant numbers of the personnel studied in Phase I (5.2% to 14.3%). In Phase II, the incidence of low serum and red cell folacin values fell in the COMRATS married and COMRATS single personnel and was reflected in increases in mean folacin levels (Table 23). The folacin levels for the RIK-male personnel remained essentially unchanged.

The hematological values for the female personnel are summarized in tables 30 and 33. Hemoglobin values were within the normal range for all of the subjects. Hematocrit values were, however, low in 10.5% of the subjects studied in Phase I. In

Phase II, only 5.0% of the subjects had low hematocrit values (Table 30). Poor reserves of iron were noted in the subjects studied in Phase I as reflected in the low serum iron saturation values and the low serum ferritin levels (Table 33). In Phase II, the incidence of subjects with low serum iron saturation values fell to 5.0% compared to an incidence of 21.1% in Phase I. Although less than observed in Phase I, the incidence of female personnel with low serum ferritin levels remained quite high in Phase II (28.9% vs. 20.0%). In the subjects studied, vitamin B-12 status was acceptable. Serum folacin status was unacceptable in 19% of the personnel in both phases. Low red cell folacin levels were encountered in 2% of the personnel. These data would suggest that the dietary intakes of folacin are marginal or inadequate for many of the female personnel at the marine base.

Although studied only in Phase I, serum levels of vitamin C were acceptable in all personnel studied (Tables 26 and 33). In contrast, serum vitamin A values were low in approximately 10% of the male personnel and 25% of the female personnel studied in Phase I (Tables 25 and 32). In Phase II, the incidence of low serum vitamin A levels increased further to a high of 80% in the female personnel. The poor vitamin A nutritional status was reflected also in the low serum carotene values observed (Tables 25 and 32).

Vitamin B_6 nutritional status was assessed in the personnel by measuring EGOT-PLP stimulation and the urinary excretion of free vitamin B_6. In the male personnel, 20.3% of the COMRATS married personnel and 14.7% of the RIK personnel had elevated EGOT-PLP stimulation values suggesting inadequate intakes of vitamin B_6 (Table 25). This was reflected in the observation that 12.0% of the male COMRATS married personnel and 7.8% of the RIK-male personnel had low urinary excretions of free vitamin B_6 (Table 28A). In Phase II, only an occasional male subject had a low excretion level of vitamin B_6 (Table 28A). The results of vitamin B_6 assessments in the female subjects (Tables 32 and 35A) were comparable to those observed for the male subjects.

Thiamin (vitamin B_1) nutritional status was evaluated in the personnel by measuring ETK-TPP stimulation and urinary thiamin excretion. In the male personnel, 19.5% of the COMRATS married personnel and 20.6% of the COMRATS single personnel had elevated ETK-TPP stimulation values suggesting inadequate intakes of vitamin B_1 (Table 25). RIK personnel had an incidence of only 12.1% with elevated values. Urinary excretion of thiamin was unacceptably low in 4.5% of the COMRATS married personnel, 7.9% of the COMRATS single personnel, and 3.5% of the RIK personnel (Table 28A). Phase II of the study revealed a reduction in the mean urinary excretion of thiamin for all groups as well as a marked increase in the incidence of personnel with low urinary excretion levels of thiamin (Table 28A). The results would suggest that a decrement in thiamin nutritional status had occurred with the change in the feeding system. In the female personnel an incidence of 16.7% was observed with elevated ETK-TPP stimulation values (Table 32). The mean urinary excretion of thiamin was also lower in Phase II when compared with Phase I (207 ug/g creatinine vs. 400 ug/g creatinine) (Table 35A). Approximately 13% of the RIK female personnel, in both Phase I and Phase II, had low urinary excretions of thiamin.

Riboflavin nutritional status was assessed in the personnel by measuring EGSSR-FAD stimulation and urinary excretion of riboflavin. The incidence of elevated EGSSR-FAD stimulation values indicative of an inadequate riboflavin status was low in the male personnel, except for the COMRATS single subjects. This group had an incidence of 11.1% in Phase I (Table 25). The incidence of personnel with low urinary excretions of riboflavin was 3.8% in the COMRATS married subjects, 7.9% in the COMRATS single subjects, and 3.5% in the RIK subjects. In Phase II, the mean urinary excretion of riboflavin was considerably lower and with an increase in the number of personnel with unacceptable urinary excretion levels of riboflavin (Table 28A). The incidence of elevated EGSSR-FAD stimulation values was 9.5% in the female personnel (Table 32). In both phases, 9.5% of the female personnel had low urinary excretion levels of riboflavin (Table 35A). These data would suggest that improvements in riboflavin nutritional status would be desirable.

Zinc nutritional status in the male personnel as judged by serum zinc levels appeared acceptable (Table 23). In the female personnel, however, 7.1% of the subjects studied had serum zinc levels considered low (Table 30). Serum copper levels were considered low in 9.8% of the COMRATS-male married personnel, 7.9% of the COMRATS single male personnel, and 4.3% of the RIK-male personnel. In the female personnel, however, 16.7% had elevated serum copper levels. High serum copper levels are associated with the use of oral contraceptive agents and may explain the high values observed in this study.

Data for the urine and serum levels of other minerals are presented in Tables 27-28B for the male personnel and in Tables 34-35B for the female personnel. Although subjects with abnormal serum calcium or phosphorus values were encountered, the significance of these values is uncertain. Low urinary excretion values for calcium, magnesium, and potassium were observed in a low percentage of the personnel studied. An exception was the 22.2% of the female personnel with low urinary magnesium excretion values (Tables 35B). Whether these values reflect inadequate dietary intakes in these respective nutrients is not well-established. Elevated levels of urinary excretion of sodium and phosphorus were observed in a small number of the personnel. The highest incidence of elevated urinary excretion of sodium was encountered in the RIK-male personnel who had an incidence of 8.8% with elevated urinary excretions of sodium (Table 35B).

Data on the assessment of protein nutritional status conducted during Phase I are presented in Tables 29A and 29B for the male personnel and Tables 36A and 36B for the female personnel. Based on serum total protein values, protein nutritional status in all of the personnel appeared satisfactory. Only an occasional subject had a low total serum protein level. In the female personnel, however, elevated serum globulin levels were observed in 12.2% of the subjects studied (Table 36A and 36B). This gave rise to low albumin/globulin ratios in these subjects (Table 36A). The reason for the elevated serum globulin values in the female personnel is unknown.

Serum lipid profiles for the personnel studied are summarized in Tables 24 and 31. Elevated serum triglycerides and serum total cholesterol were observed in a relatively high percentage of the male personnel. In Phase II, 52.6% of the COMRATS married personnel were at risk regarding serum triglyceride levels (Table 24). In this same group, 23.7% had elevated serum total cholesterol levels. This was reflected in 24.3% of the group having low serum HDL cholesterol levels. In general, the incidence of abnormal lipid profiles was somewhat less in the COMRATS single personnel and the RIK personnel (Table 24). In contrast, few of the female personnel had abnormal lipid profiles (Table 31).

In Tables 38A and 38B are summarized relationships examined in the data obtained on the combined male and female personnel. Several correlations are of interest. The correlations of serum ferritin with hemoglobin, hematocrit, serum iron saturation, and TIBC emphasizes the usefulness of serum ferritin measurements. The high correlations between serum folacin and red cell folacin strengthens the basis for the use of these two parameters to assess folacin nutritional status. Unexpected were the interrelationships between the urinary excretions of thiamin, riboflavin, and vitamin B_6. Of significance is the negative correlation between serum cholesterol and serum HDL cholesterol.

Dietary and Biochemical Relationships. Considering the variability between individuals for nutrient requirements and taking into account that calculated total nutrient intake does not reflect actual nutrient absorption, evaluation of dietary nutrient intake should be considered in relation to records of clinical and/or biochemical assessment in order to assess the actual nutritional status of the individual or population. However, it is not always possible to have dietary, biochemical, and clinical records and therefore it is of value to know if dietary intakes can predict biochemical nutritional status. Correlations from this study between biochemical status indicators and nutrient intakes are listed in Tables 39-40. For purposes of examining relationships between biochemical and dietary parameters, the calculated nutrient intake included nutrients from foods and beverages as well as nutrients contributed from nutrient supplements. Males were combined into one group from phase I and phase II and females were likewise combined into one group. All dietary parameters were calculated in both phases, but some of the biochemical measures were studied only in phase I.

Significant correlations were found for males between urinary thiamin, riboflavin, free vitamin B-6, calcium, phosphorus, magnesium and the corresponding dietary parameter. The urinary and dietary riboflavin correlation coefficient was 0.60. The correlation coefficients for the other nutrients ranged between 0.15 and 0.18. Urinary sodium and potassium did not correlate significantly with dietary sodium and potassium for the males. (Calculated dietary sodium did not include salt added at the table or during cooking and therefore the lack of a significant correlation is not unexpected.) Females also had many of the same significant correlations although it should be noted that fewer females than males were studied. Significant correlations for the females included urinary thiamin, free vitamin B-6, calcium, *phosphorus and sodium with the corresponding dietary paramenter.* For the females, a correlation coefficient of 0.69 was found between urinary free vitamin B-6 and dietary vitamin B-6, a coefficient of 0.42 between urinary and dietary phosphorus, and coefficients of 0.28 for urinary and dietary thiamin, calcium and sodium.

Some significant correlations were found between blood and dietary parameters. Significant correlations were found for the males between serum and dietary vitamin C, serum and dietary folate, RBC folate and dietary folate, EGOT-PLP stimulation and dietary vitamin B-6, and EGSSR-FAD stimulation and dietary riboflavin. Significant correlations between blood and dietary parameters were found for the females between serum and RBC folate and dietary folate. The females had correlation coefficients of about 0.50 for dietary and blood folate relationships. It is of interest to note that the females had stronger correlation coefficients than the males for most of the dietary-biochemical relationships investigated.

It was pointed out in both the nutrient intake and biochemical evaluation sections of this report that vitamin A was a nutrient of concern at the Twentynine Palms MCB. However, low correlation coefficients were observed between serum and dietary vitamin A levels for both the male and female populations (Table 40). Tables 41 and 42 present a closer examination of the dietary and serum vitamin A relationship. It is clear from these data that individuals with low current dietary vitamin A levels do not necessarily have low serum vitamin A levels. The lack of relationship between short-term dietary and serum levels is in agreement with what other investigators have noted.

CONCLUSIONS

This study was conducted to evaluate the nutritional impact of a new "multi-restaurant" food service system on RIK enlisted personnel at the Twentynine Palms Marine Corps Base. In addition, the study assessed the nutritional health of the enlisted male and female Marines. Data were collected on COMRATS personnel in order to provide for a control population.

The food service system's ability to impact the nutritional health of the enlisted personnel is dependent on the number of meals personnel consume at the dining hall and their food selections. Male RIK personnel consumed 50% of their meals and female RIK personnel 20% of theirs at the dining halls. These percentages were the same before and after the "multi-restaurant" food service system installation. The percentage of daily calories consumed by RIK personnel at the dining halls did not significantly change with the new food service system. It was also found that there was a significant increase in the percentage of daily calories from outside restaurants and vendors and from snacks after food service system modifications.

Caloric intake, when compared to the military dietary allowances, was inadequate for RIK and COMRATS personnel. However, when short-term (a four-week interval) caloric balance was measured in phase II, caloric intake maintained weight. The reported low mean caloric intakes might have resulted from under-reporting of food intake, from caloric needs for the activity level being less than the MDA, or from some individuals dieting to meet weight for height standards. (A weight control program was in effect during both phases of the study.) As has been previously noted, 32% of the RIK females, 11% of the RIK males and 21% of the COMRATS personnel exceeded the weight for height standards during phase II. This was an increase for all groups over what had been found in phase I.

The percentage of fat calories consumed by RIK and COMRATS personnel remained at about 40% of the daily calories after food service changes. Serum lipid profiles with few exceptions, were normal in the female personnel. In the male personnel, however, elevated serum triglycerides were observed in 25% or more of the subjects studied in both study phases. The highest incidence occurred in the COMRATS-married personnel. Elevated serum total cholesterol levels were also common in this group as was a higher cholesterol risk factor. There was a significant decrease in cholesterol consumption in phase II for all groups except RIK males from the force troops. However, since the COMRATS personnel also exhibited the decrease in cholesterol consumption, it may be that factors other than the food service changes were causative.

The changes in the feeding system improved the iron status of male and female RIK personnel. Although 60% of females continued to consume less than the MDA for iron, iron density of meals consumed by all personnel at the dining halls improved markedly. Little evidence of anemia was observed, but a latent iron deficiency appeared to exist in the female personnel. This deficiency was reflected in low serum values for iron, iron saturation, and ferritin. Iron biochemical nutritional status improved in phase II for the females. It was also noted that more females were taking iron supplements in phase II.

Vitamin A nutritional status was less than adequate in both male and female RIK personnel as judged by dietary intake and serum vitamin A levels. Their vitamin A nutritional status was inadequate in phase I and further deteriorated in phase II. The vitamin A intakes for COMRATS personnel remained about the same in both study phases but a greater proportion of the personnel had low serum vitamin A levels in phase II. In addition, the dining hall meals consumed in phase II by RIK personnel contained lower vitamin A density than in phase I. Therefore, the feeding system changes further contributed to an already existent nutritional problem.

There was some biochemical evidence of less than optimum intakes of thiamin, riboflavin, and vitamin B-6. This was more prevalent in the females and COMRATS personnel. The mean urinary excretion of thiamin and riboflavin fell in phase II from the levels that had been measured in phase I. The thiamin intakes slightly improved in phase II for male and female RIK personnel, but 40% to 50% of each population consumed marginal thiamin intakes. There was, however, a significant improvement in the thiamin density of meals selected by females in the dining halls. Low riboflavin intakes paralleled low riboflavin biochemical status. The niacin density of dining hall meals consumed by females significantly improved in phase II.

Evidence of low folacin biochemical status was noted which improved in phase II in the male personnel but not in the female personnel. Urinary excretions of magnesium indicated that some of the personnel may have had low intakes of this nutient. Although complete food nutrient composition data were not available for folate and magnesium, there was a significant decrease in the mean folate and magnesium intake for all groups in phase II. There was also a significant decrease in their respective nutrient density intakes.

Calcium intakes were less than adequate for the RIK-females and the problem increased in phase II. Forty percent of the females consumed low calcium density intakes in phase II. In addition, there was an increase in the number of females consuming marginal or low calcium density dining hall meals. Sodium intakes for male groups exceeded the safe and adequate range set forth in the 1980 RDA. This was true even though table and cooking salt were not included in calculated intake values.

Vitamin C and vitamin B-12 nutritional status were satisfactory for all personnel. Zinc nutritional status appeared acceptable as judged by serum zinc levels. With few exceptions, protein nutritional status was acceptable.

RECOMMENDATIONS

Alter the "Multi-Restaurant" menus to include more high vitamin A content foods and foods which would assist the Marine in lowering his/her percentage of daily fat calories.

Encourage increased use of the dining facilities by women Marines.

Develop a Marine Nutrition Education and Awareness Program to help Marines prevent and correct their own nutrition problems.

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APPENDIX A. Figures 1 through 21

APPENDIX B. Tables 1 through 42

A P P E N D I C E S

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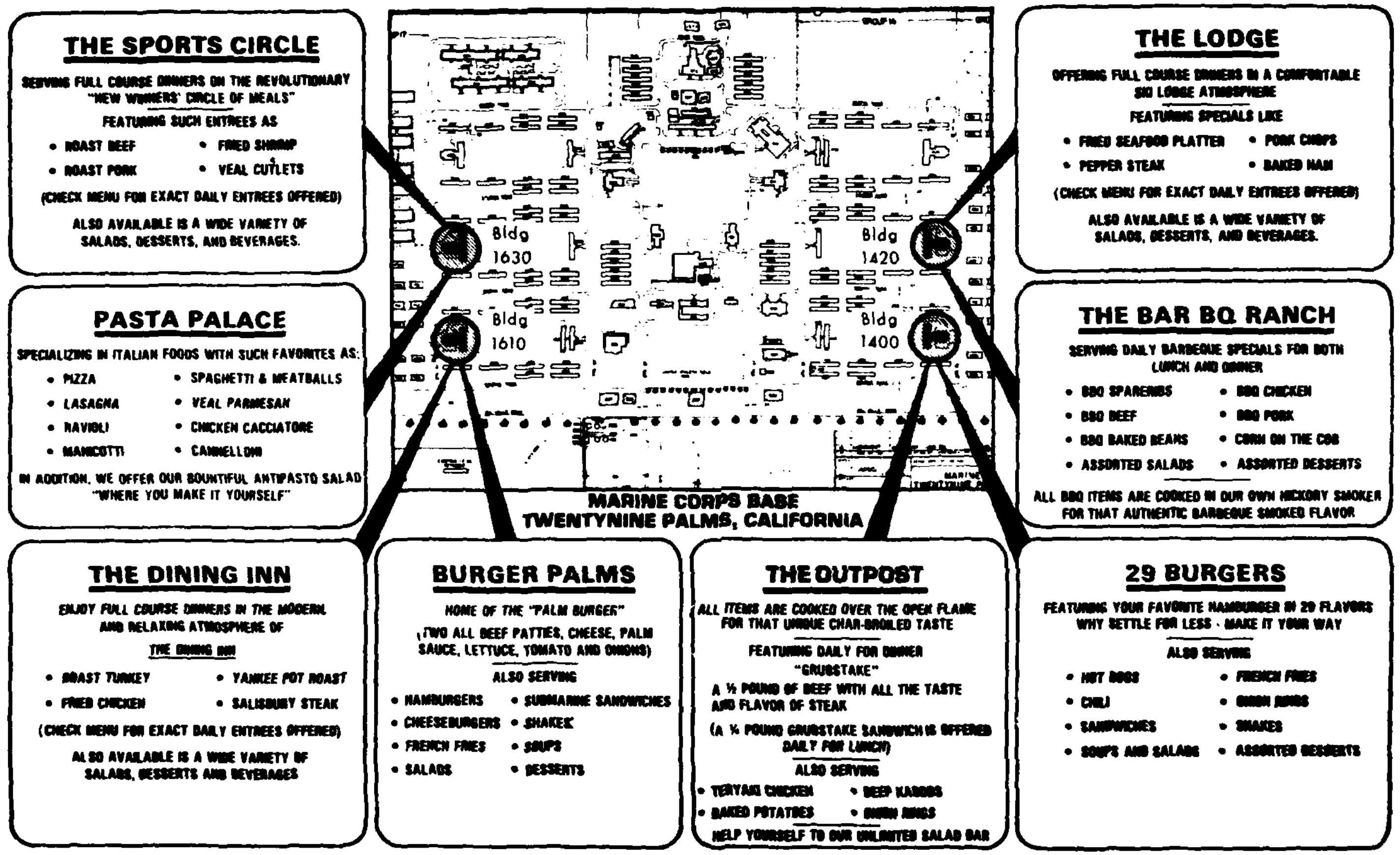


Figure 1. "Multi-Restaurant" Systems's Abbreviated Menus.

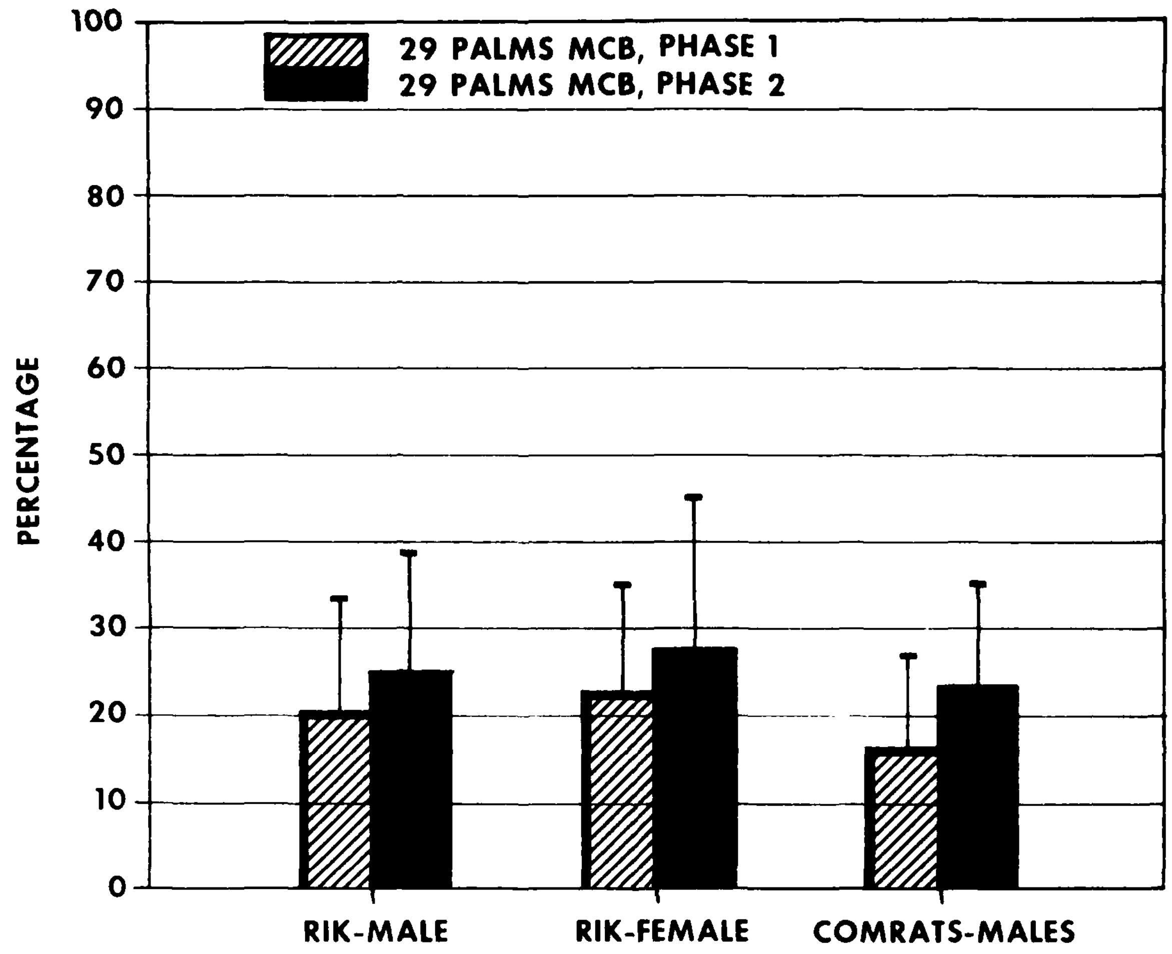


Figure 2. Percentage of Average Daily Energy From Snacks.

37-Kretsch

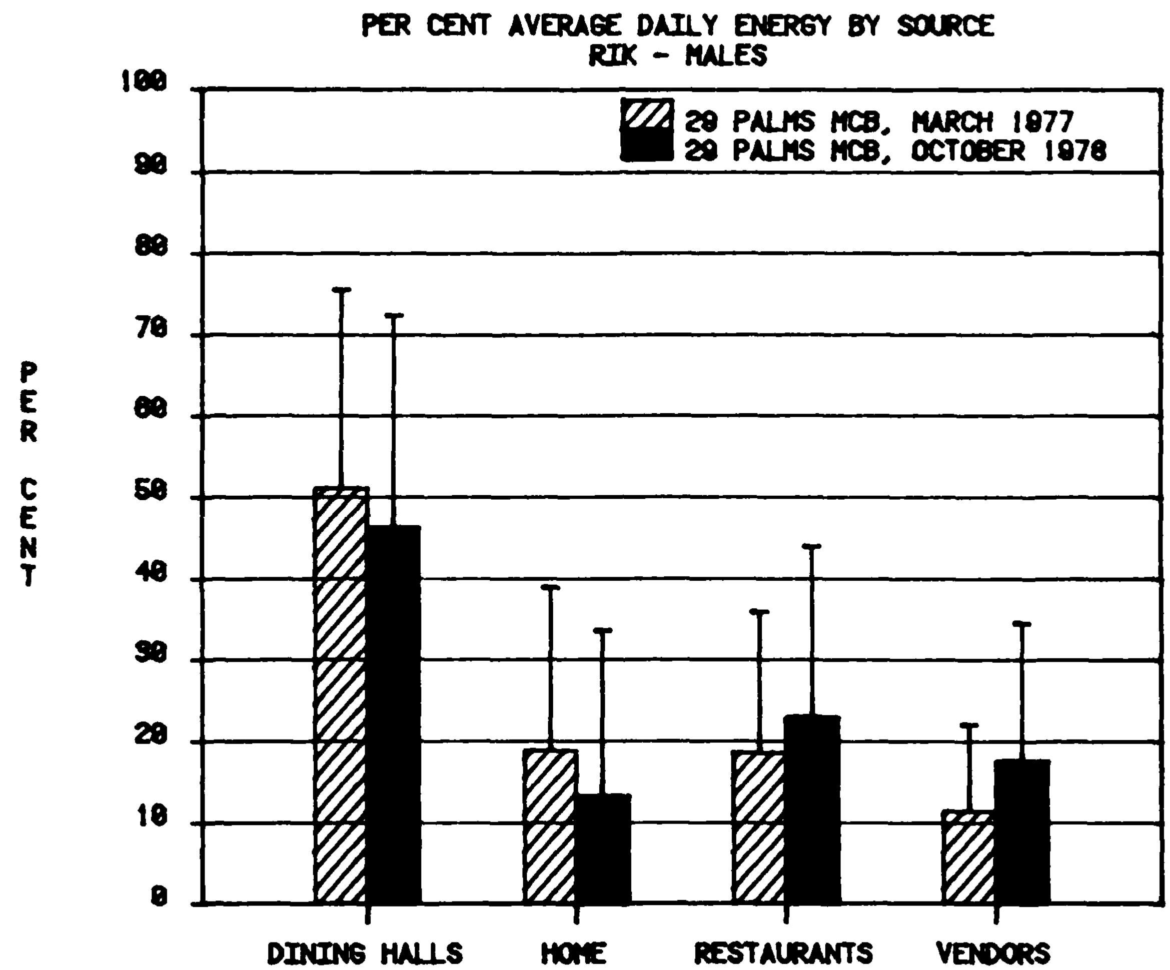


Figure 3A. RIK-Males. Percentage of Average Daily Energy by Source.

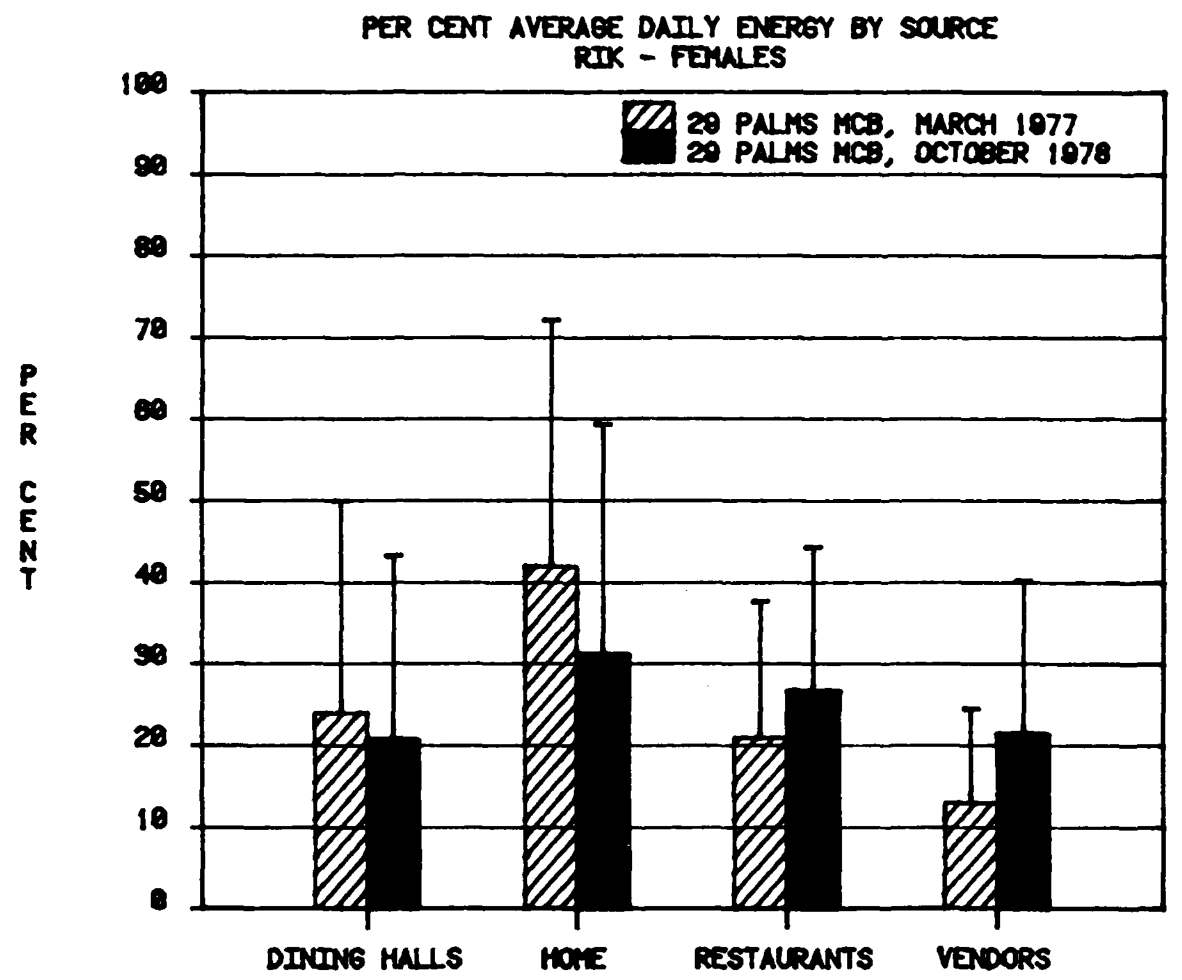


Figure 3B. RIK-Females. Percentage of Average Daily Energy by Source.

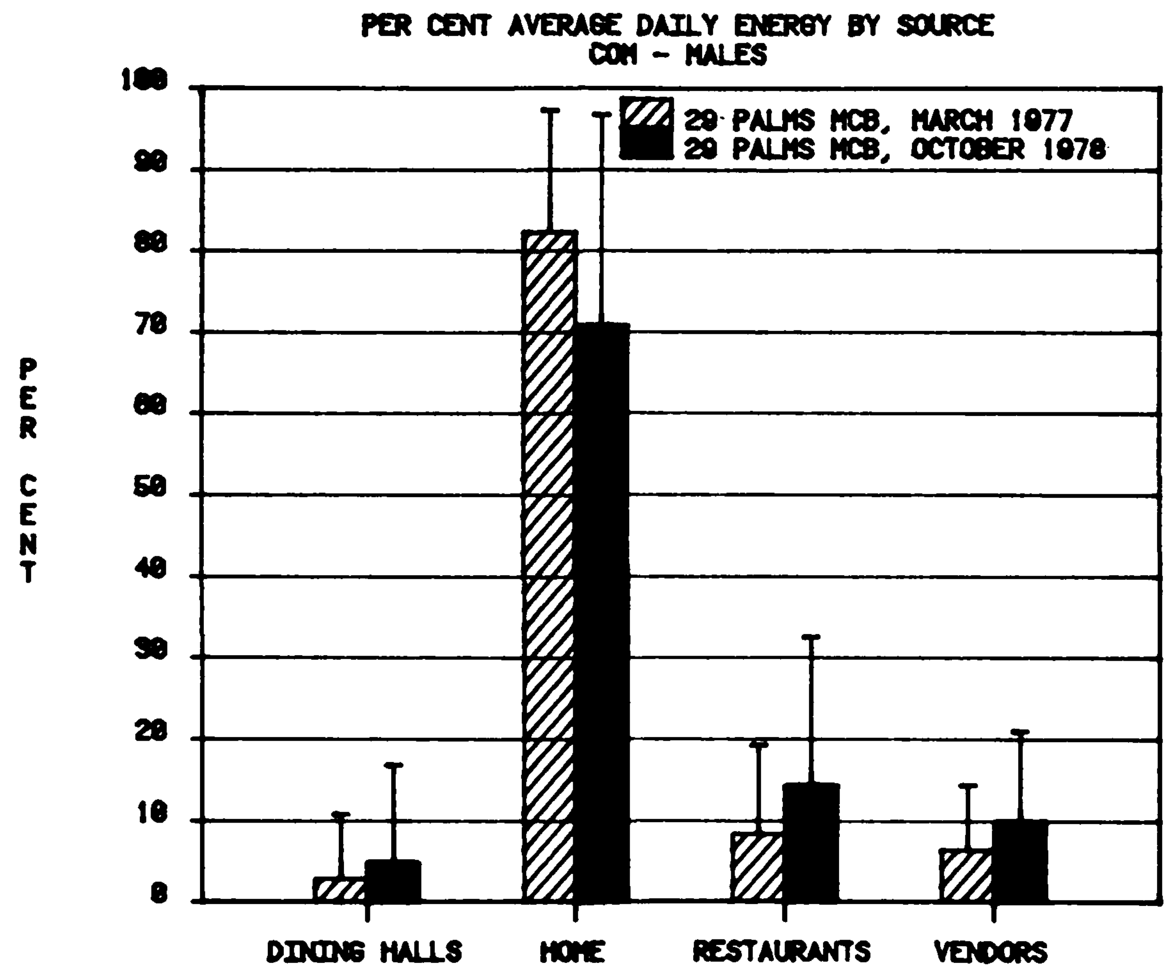


Figure 3C. COM-Males. Percentage of Average Daily Energy by Source.

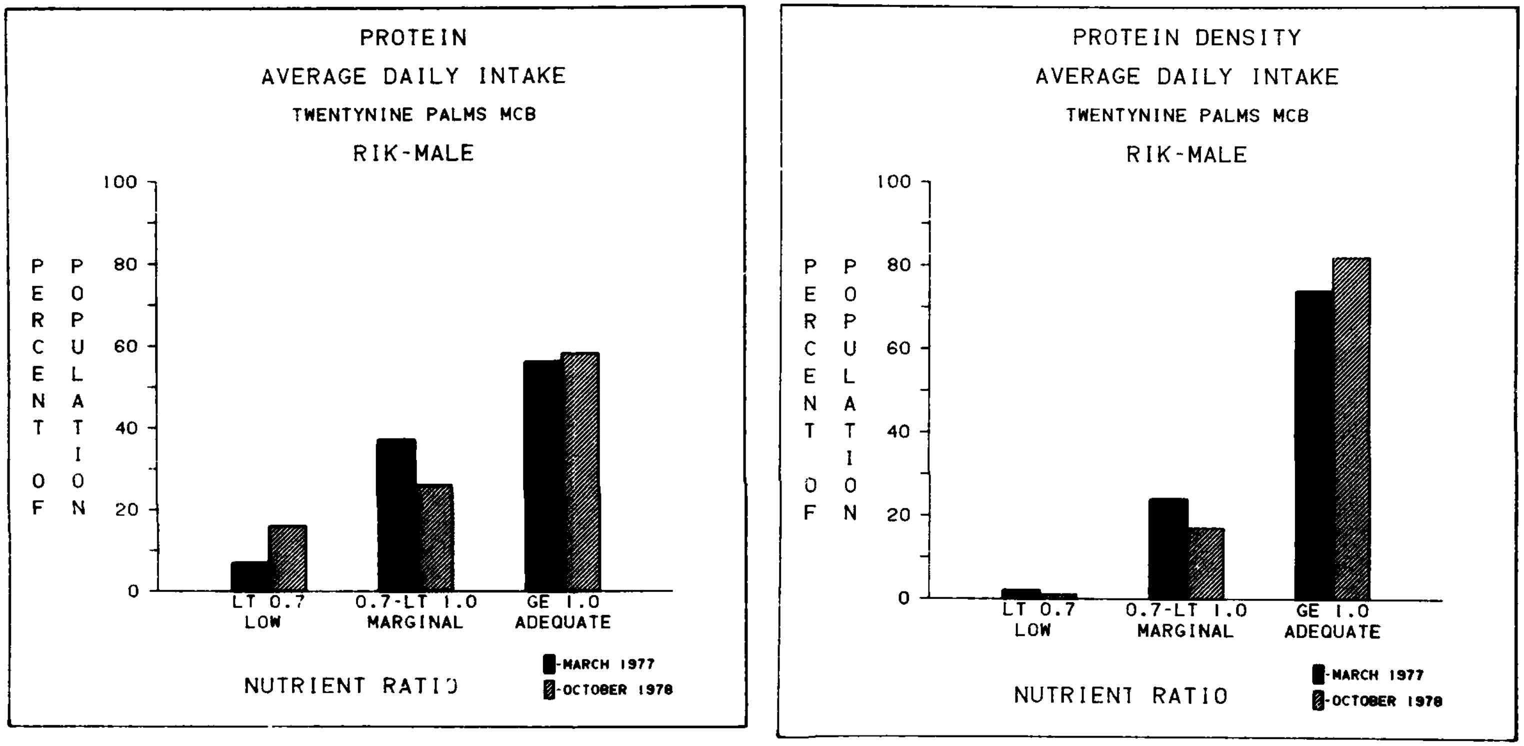


Figure 4A. RIK-Males. Distribution of Average Daily Protein Intake and Average Daily Protein Density Intake.

41-Kretsch

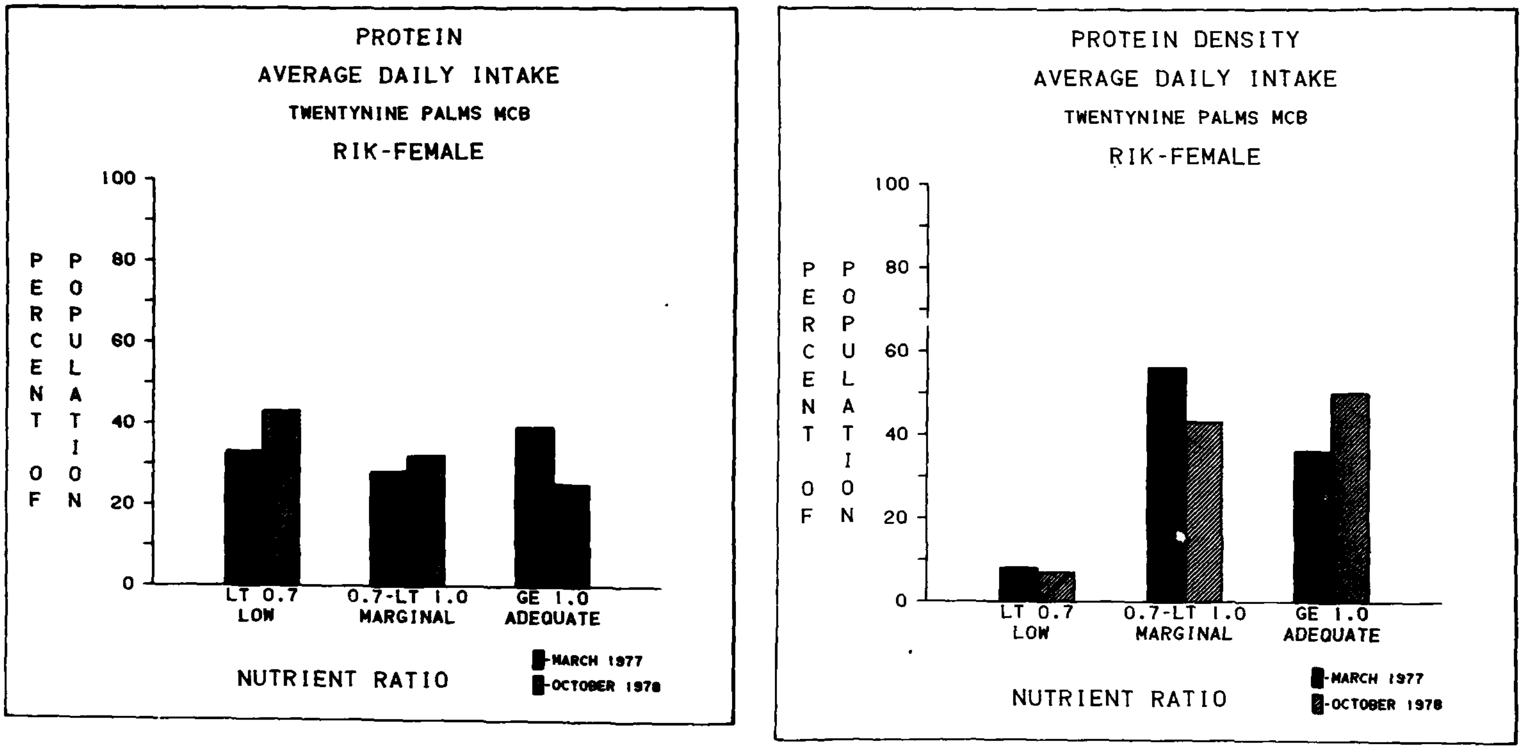


Figure 4B. RIK-Females. Distribution of Average Daily Protein Intake and Average Daily Protein Density Intake.

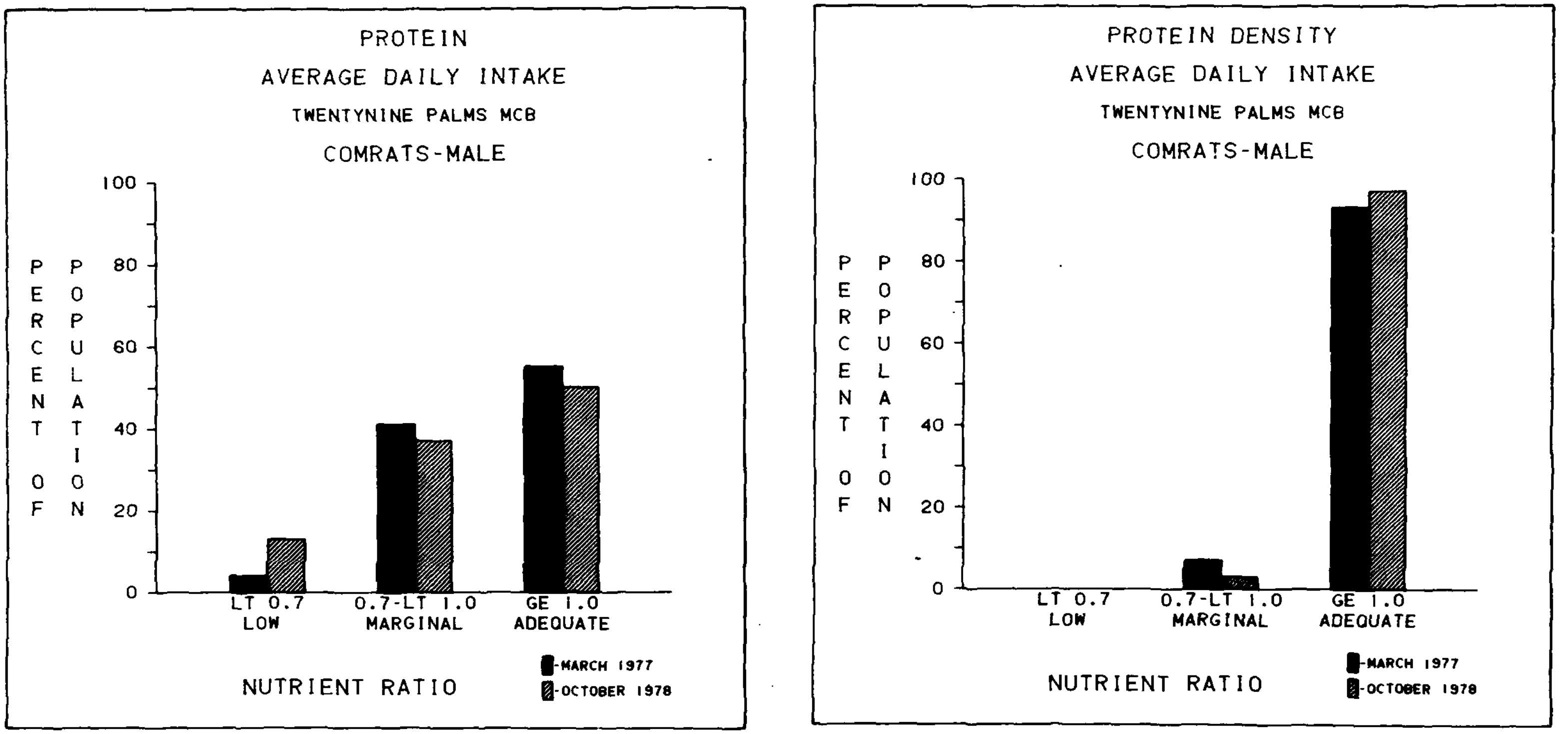


Figure 4C. *COMRATS-Males*. Distribution of Average Daily Protein Intake and Average Daily Protein Density Intake.

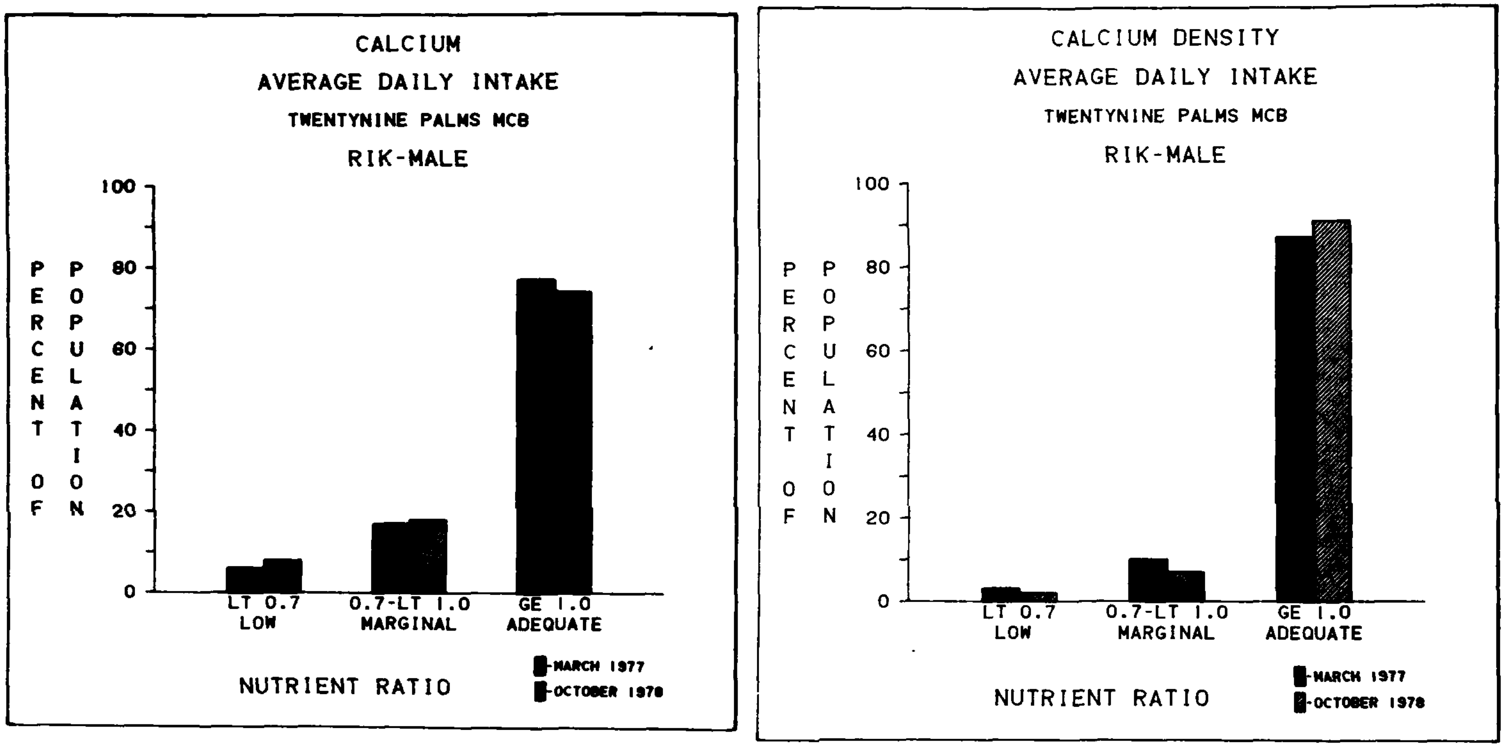
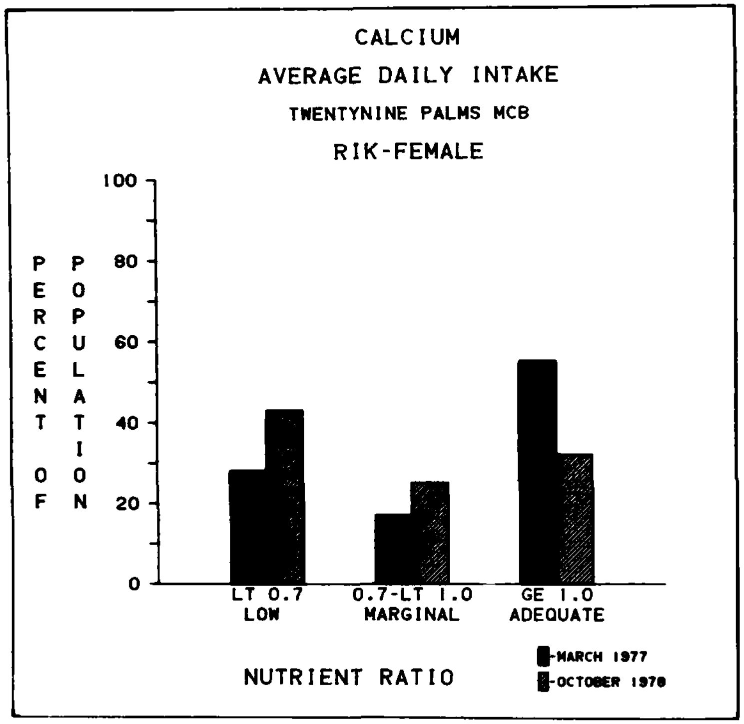


Figure 5A. RIK-Males. Distribution of Average Daily Calcium Intake and Average Daily Calcium Density Intake.



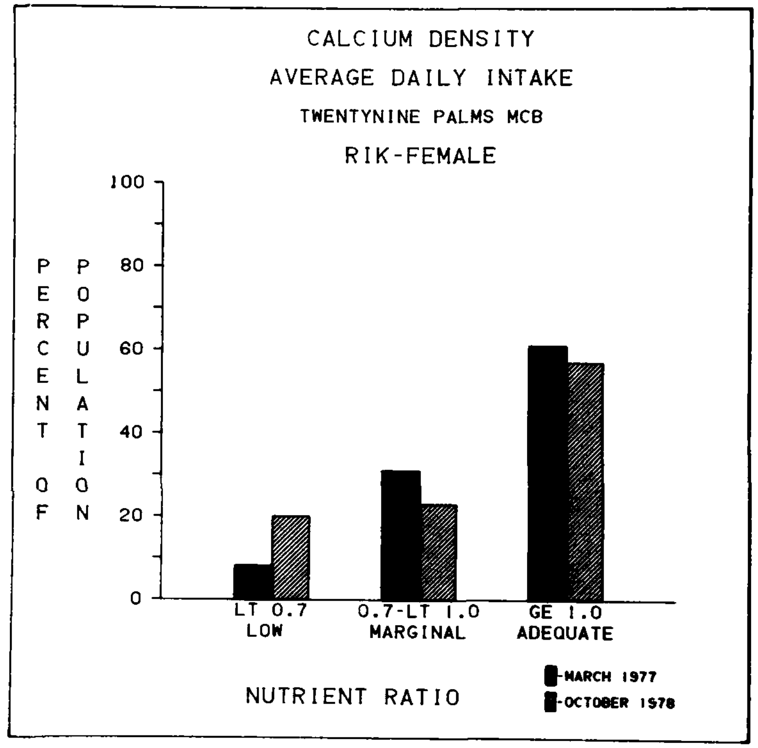


Figure 5B. RIK-Females. Distribution of Average Daily Calcium Intake and Average Daily Calcium Density Intake.

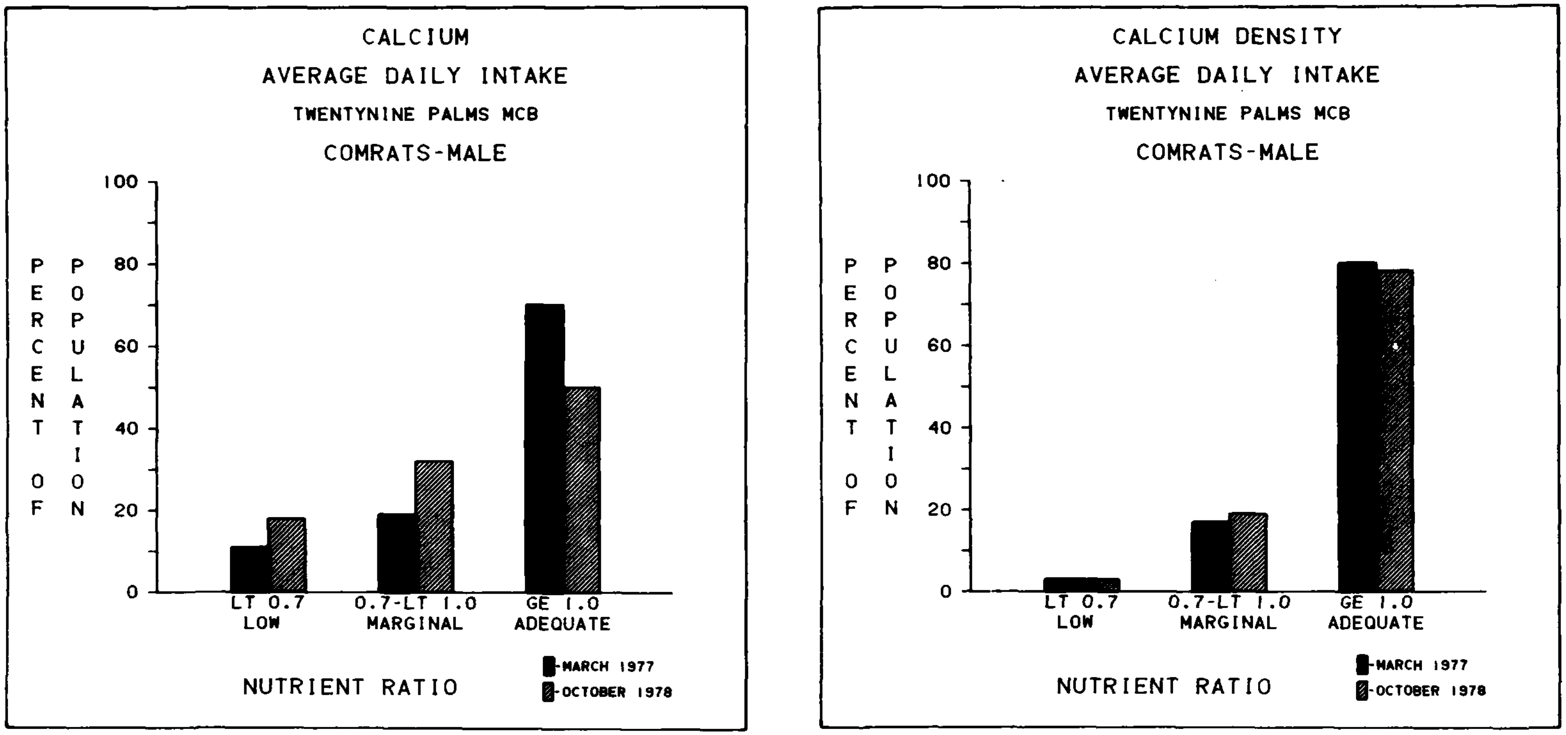
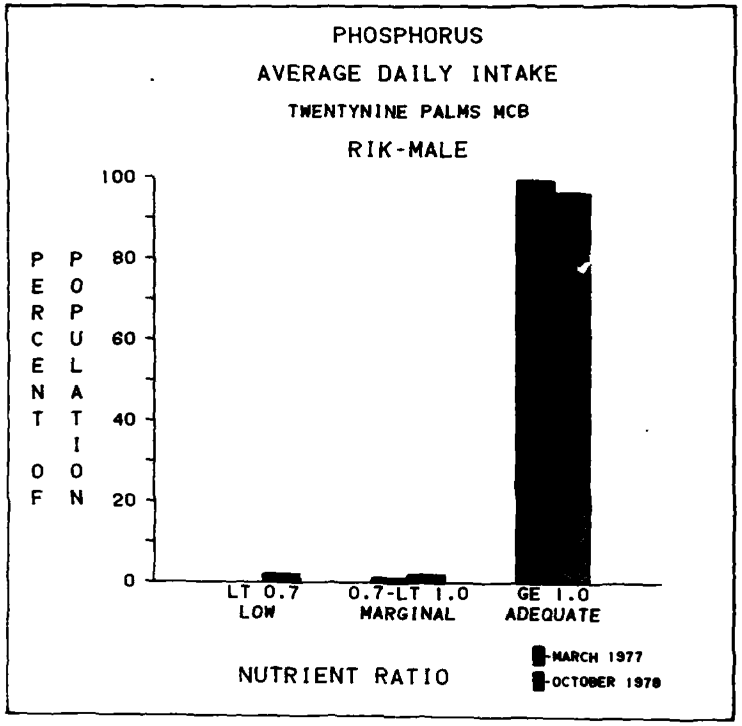


Figure 5C. COMRATS-Males. Distribution of Average Daily Calcium Intake and Average Daily Calcium Density Intake.



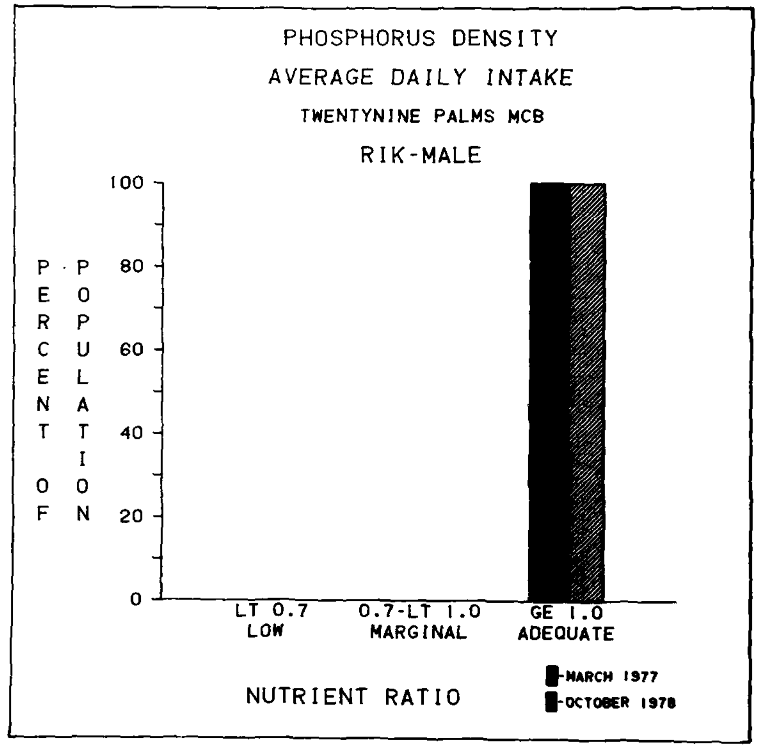


Figure 6A. RIK-Males. Distribution of *Average Daily Phosphorus Intake and Average Daily* Phosphorus Density Intake.

47-Kretsch

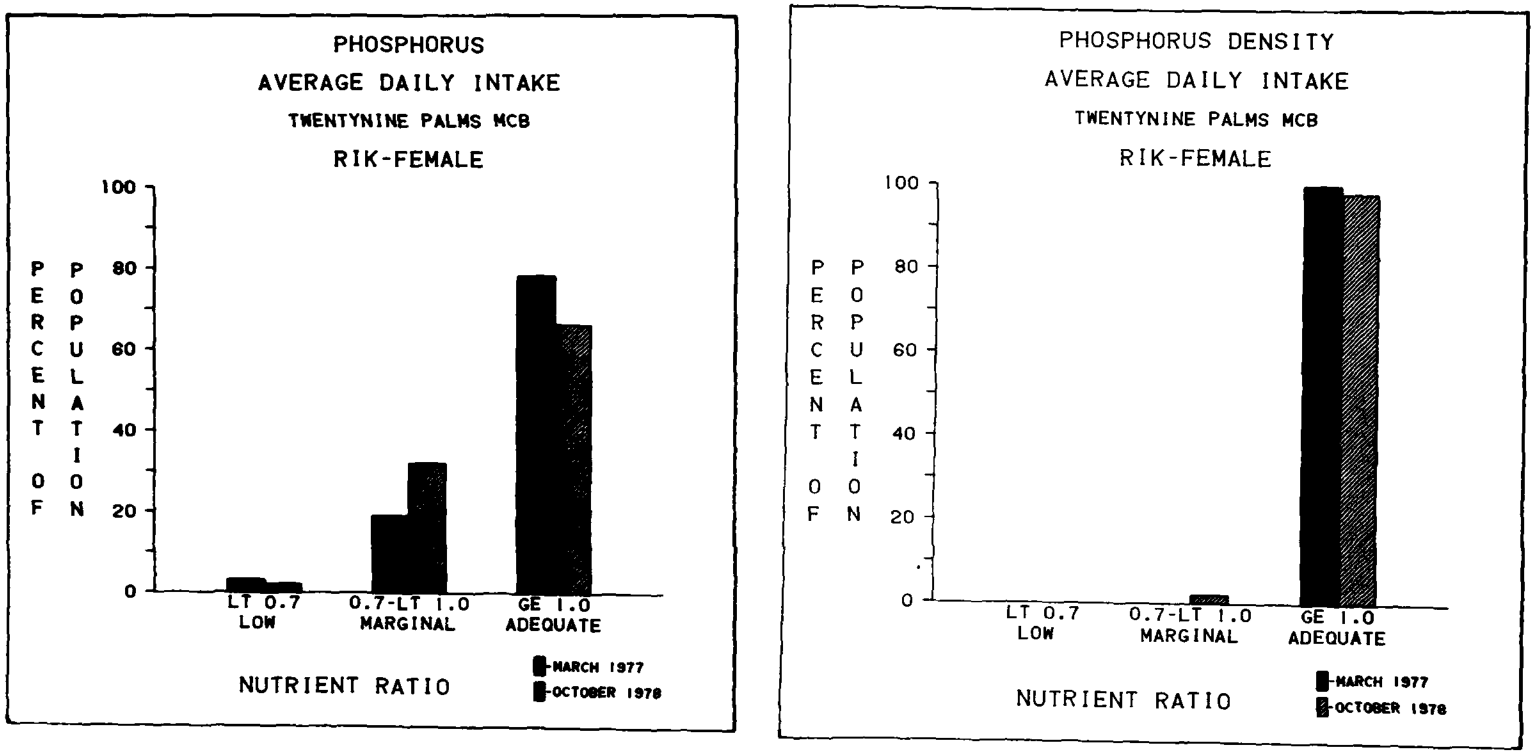


Figure 6B. RIK-Females. Distribution of Average Daily Phosphorus Intake and Average Daily Phosphorus Density Intake.

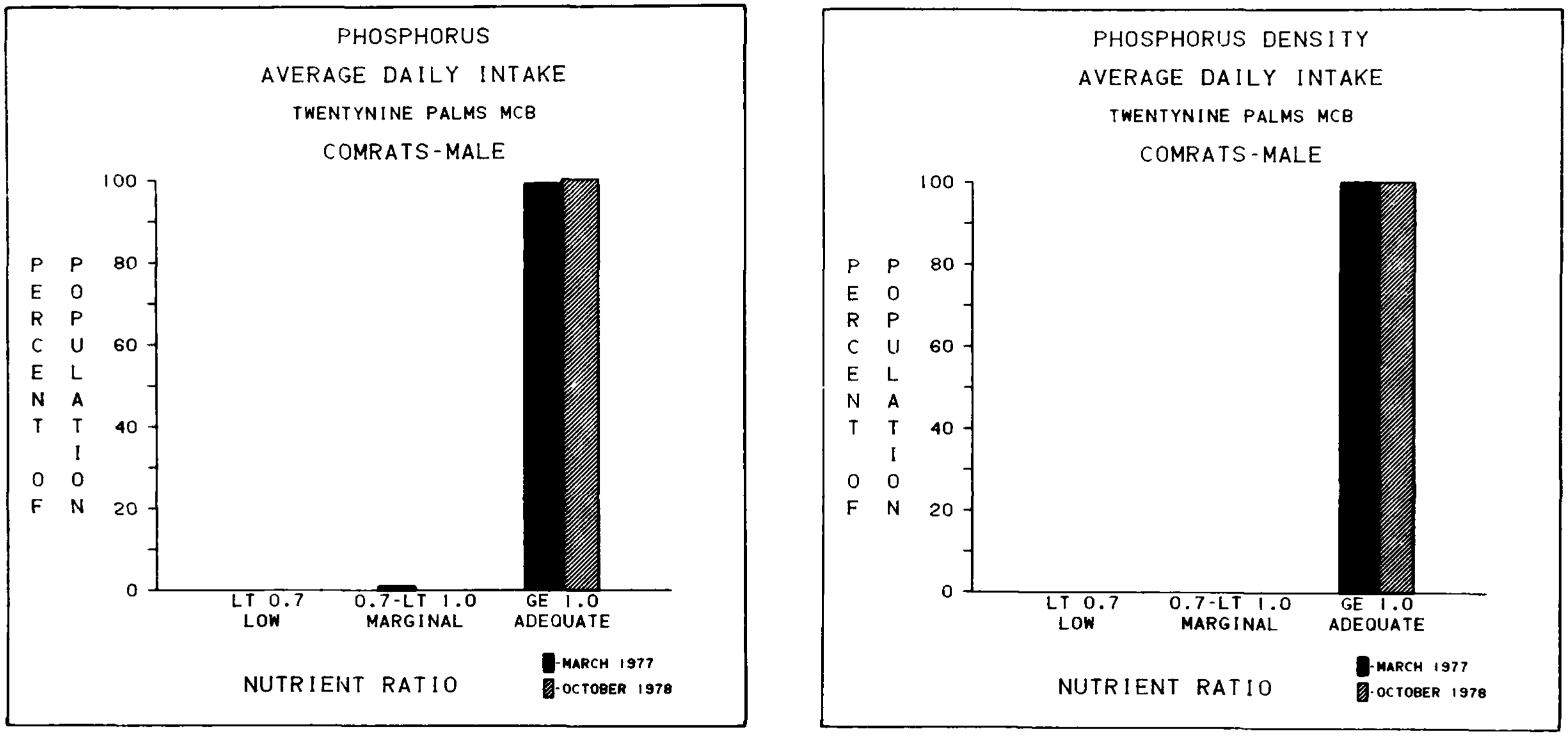
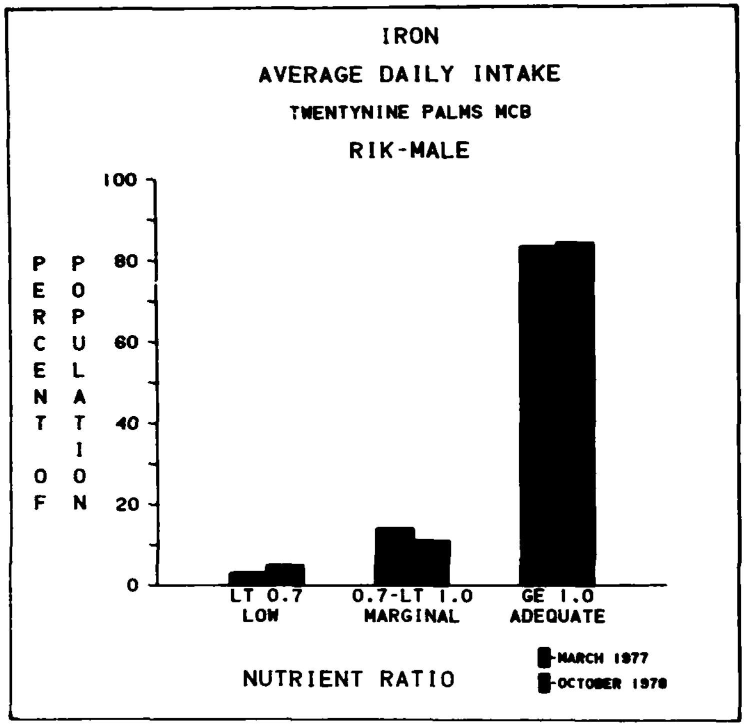


Figure 6C. COMRATS-Males. Distribution of Average Daily Phosphorus Intake and Average Daily Phosphorus Density Intake.

49-Kretsch

50-Kretsch



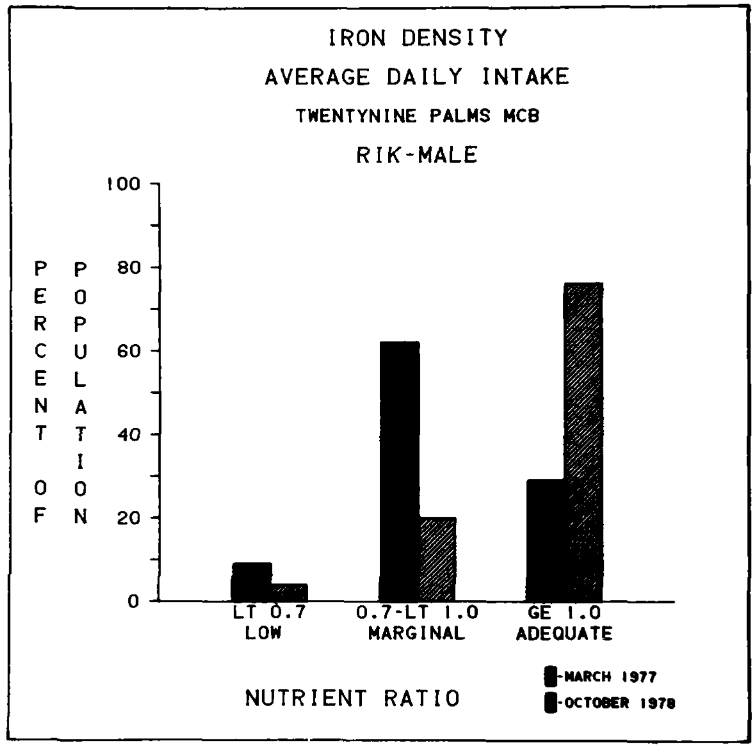


Figure 7A. RIK-Males. Distribution of Average Daily Iron Intake and Average Daily Iron Density Intake.

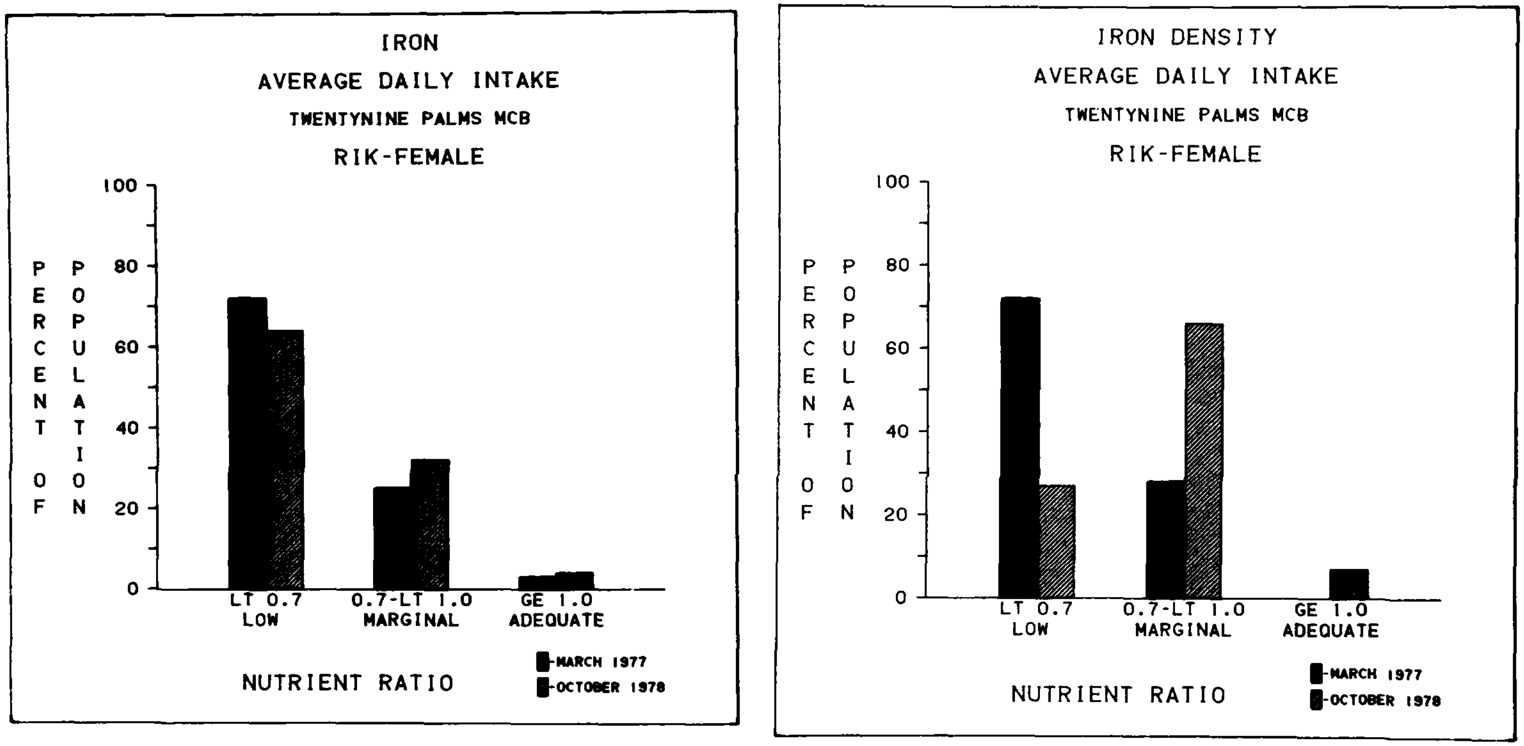
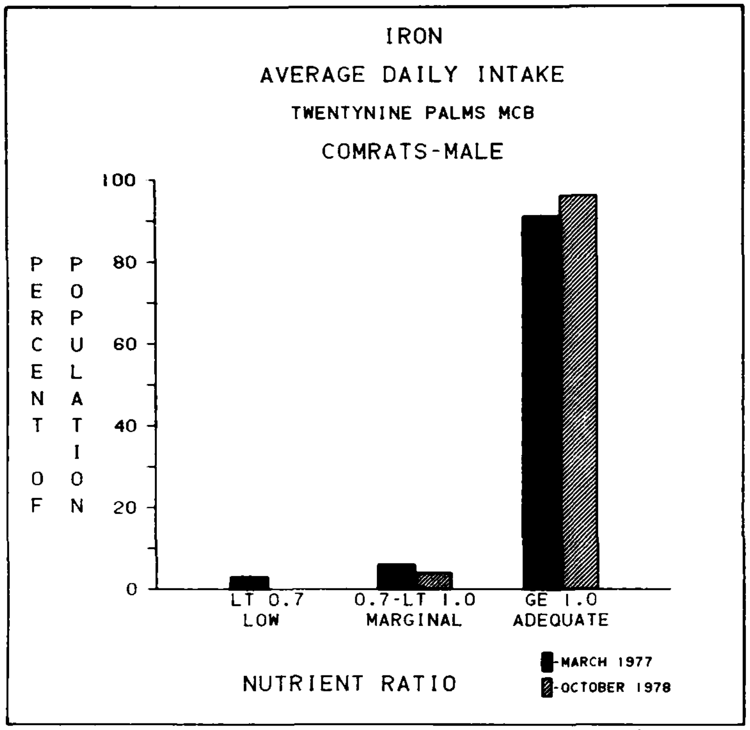


Figure 7B. RIK-Females. Distribution of Average Daily Iron Intake and Average Daily Iron Density Intake.



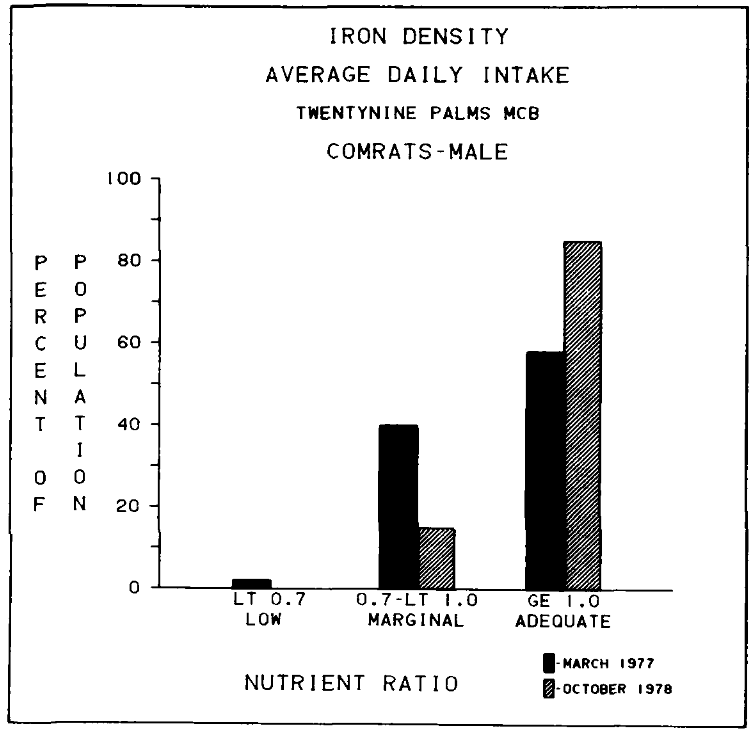
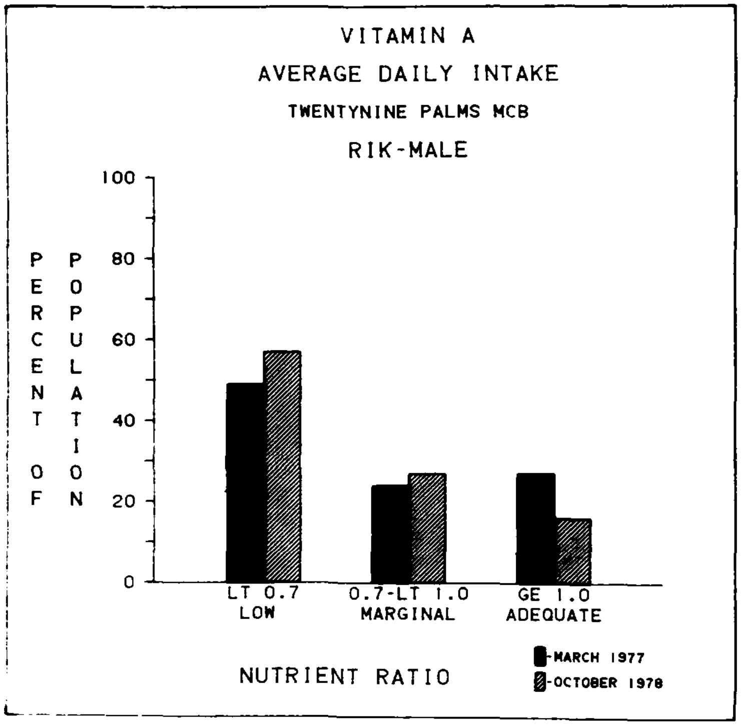


Figure 7C. COMRATS-Males. Distribution of Average Daily Iron Intake and Average Daily Iron Density Intake.



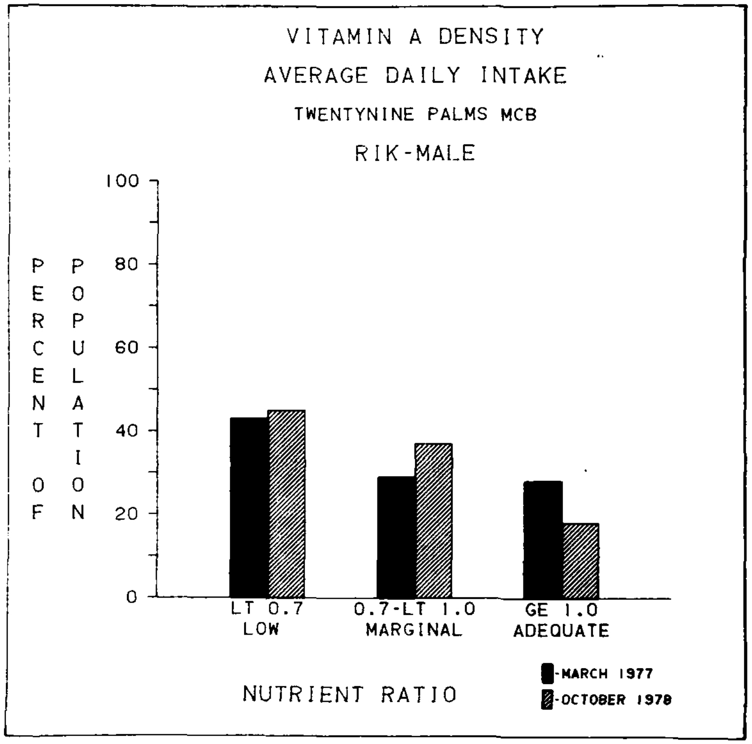
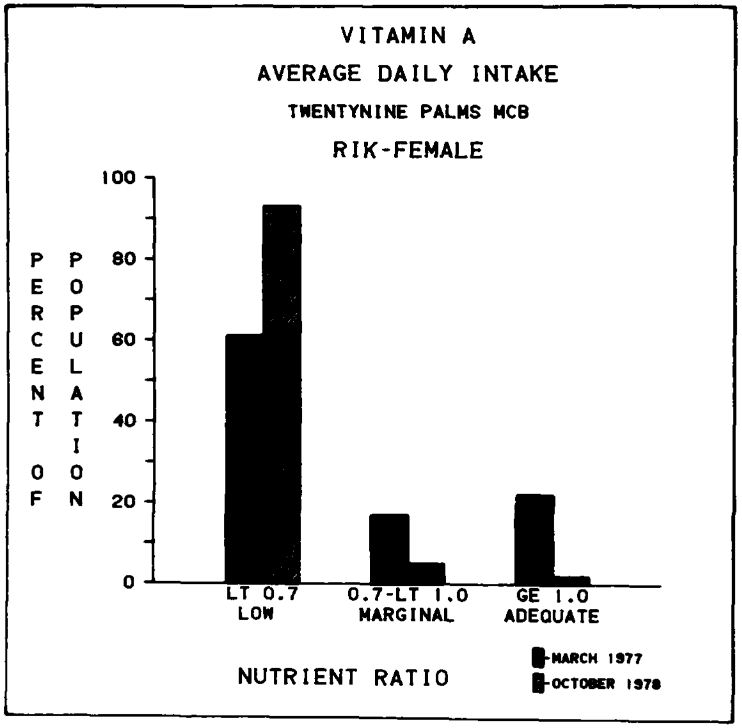


Figure 8A. RIK-Males. Distribution of Average Daily Vitamin A Intake and Average Daily Vitamin A Density Intake.

53-Kretsch



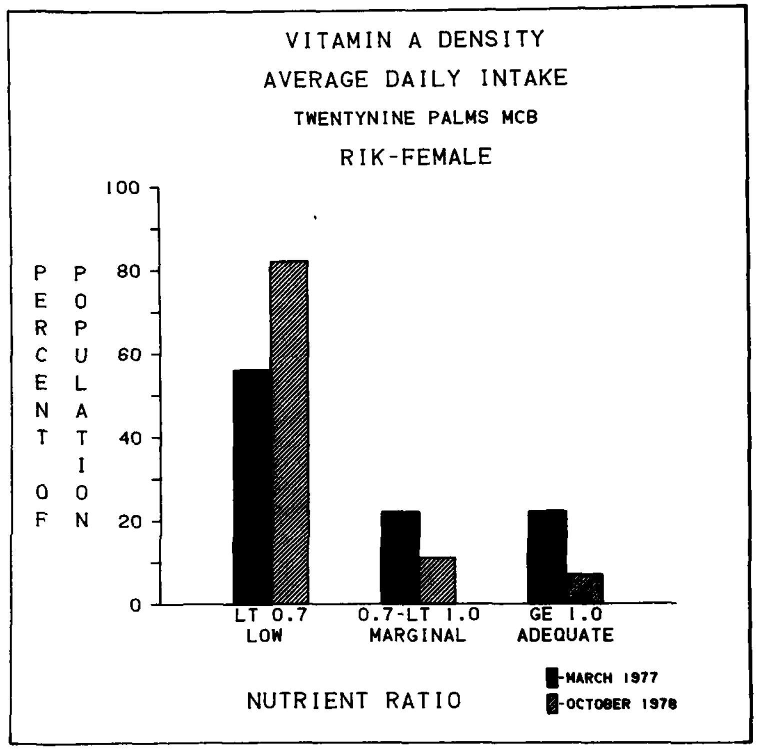


Figure 8B. RIK-Females. Distribution of Average Daily Vitamin A Intake and Average Daily Vitamin A Density Intake.

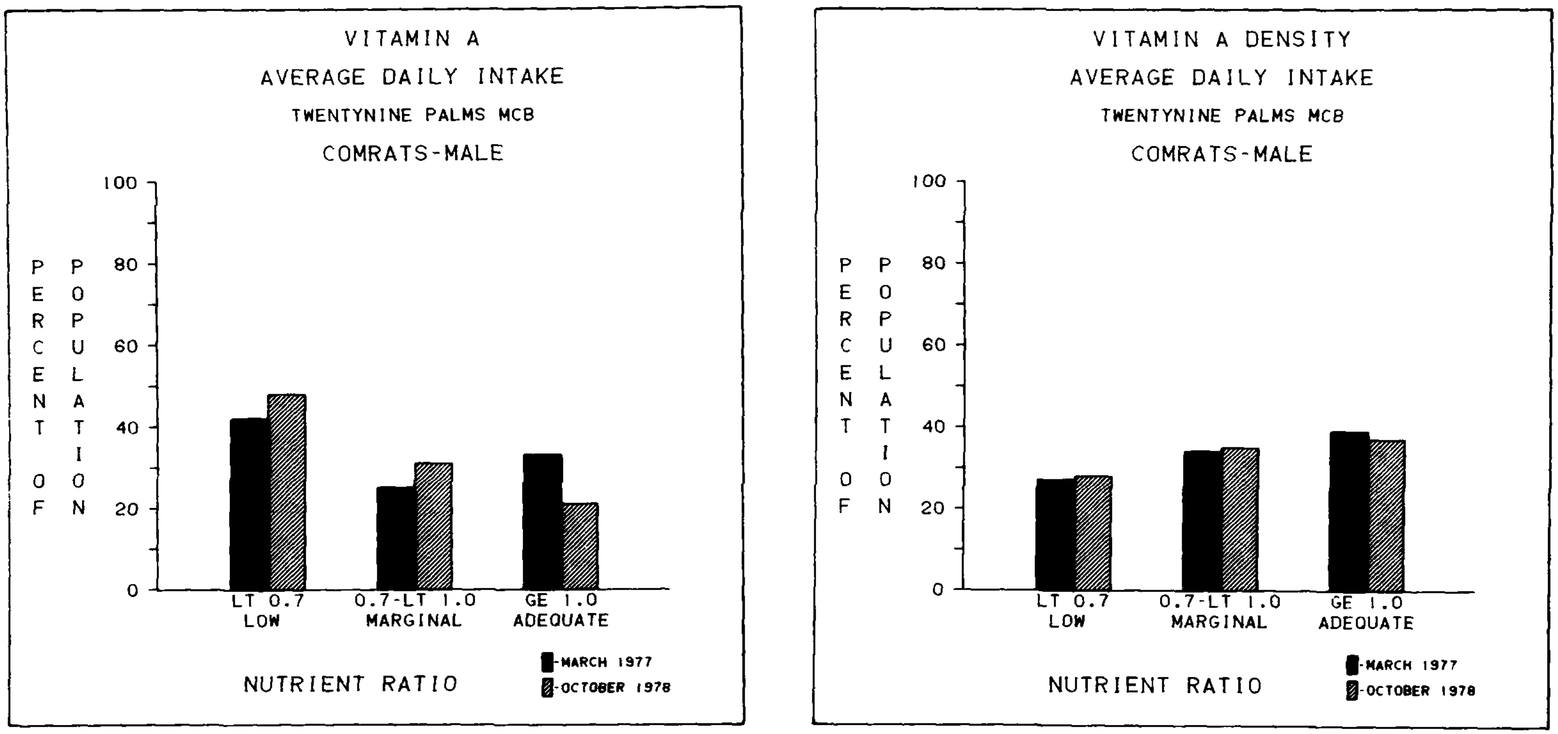


Figure 8C. COMRATS-Males. Distribution of Average Daily Vitamin A Intake and Average Daily Vitamin A Density Intake.

55-Kretsch

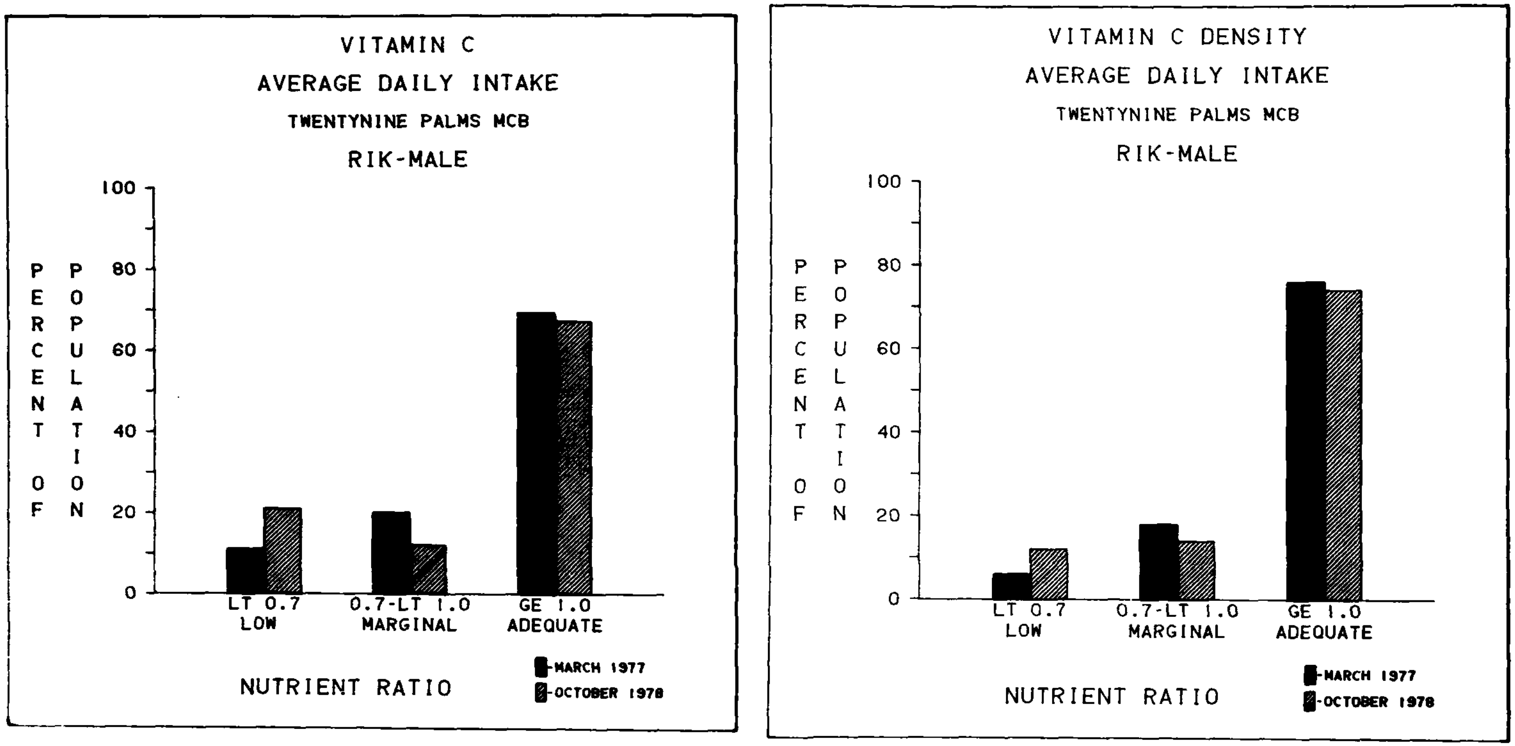
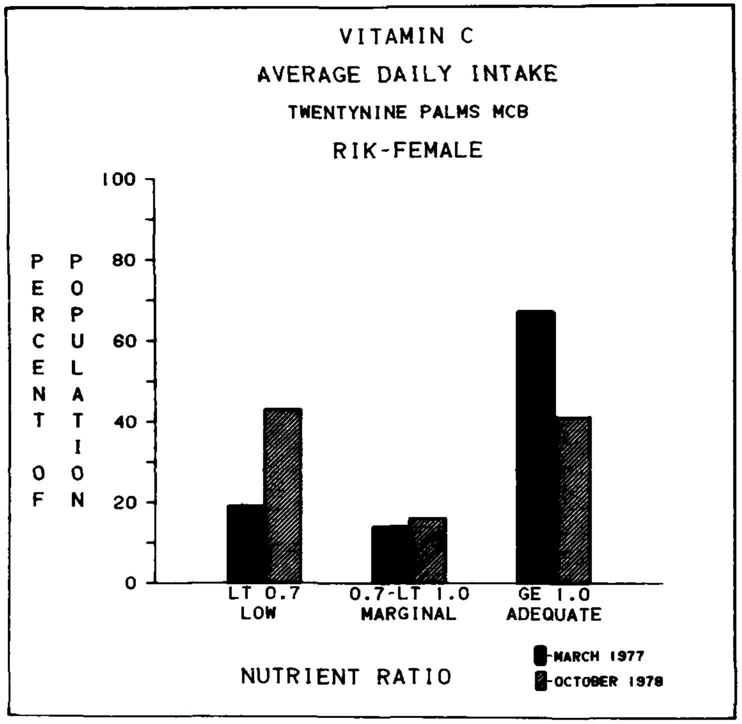


Figure 9A. RIK-Males. Distribution of Average Daily Vitamin C Intake and Average Daily Vitamin C Density Intake.



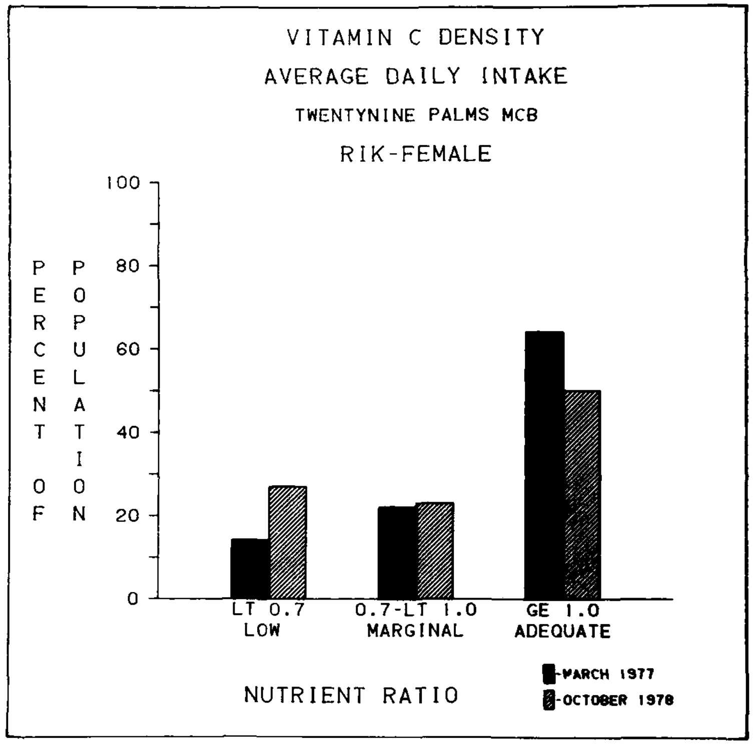


Figure 9B. RIK-Females. Distribution of Average Daily Vitamin C Intake and Average Daily Vitamin C Density Intake.

57-Kretsch

58-Kretsch

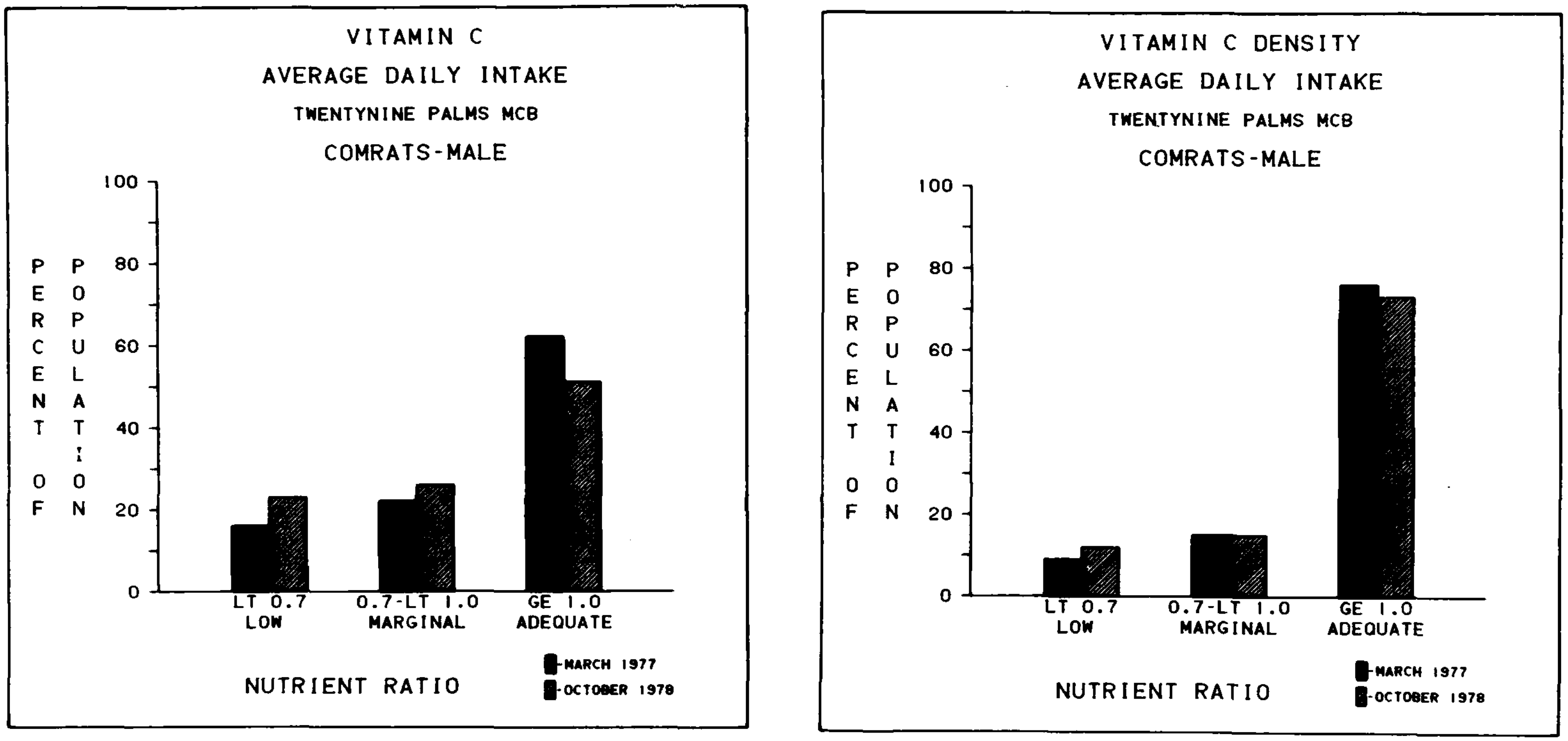


Figure 9C. COMRATS-Males. Distribution of Average Daily Vitamin C Intake and Average Daily Vitamin C Density Intake.

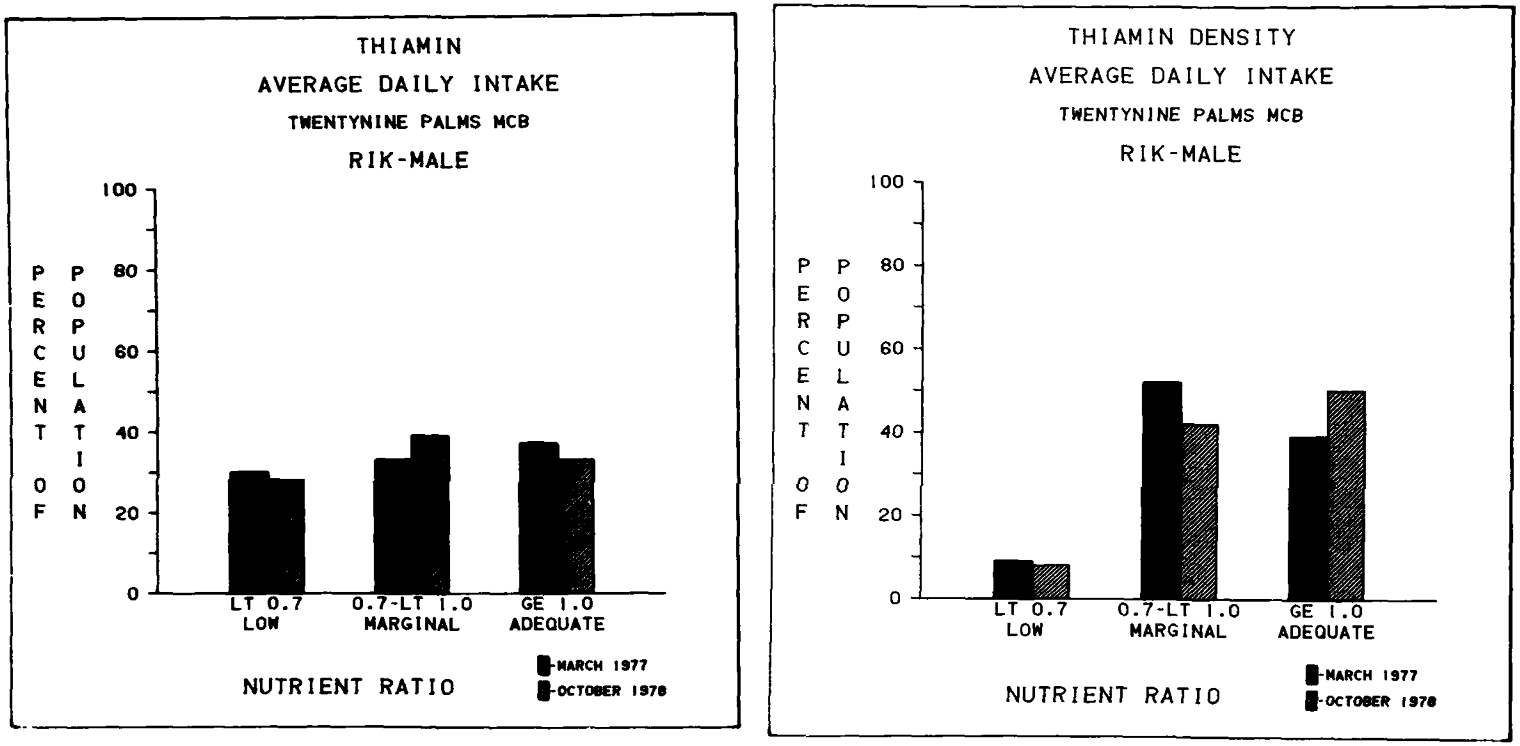
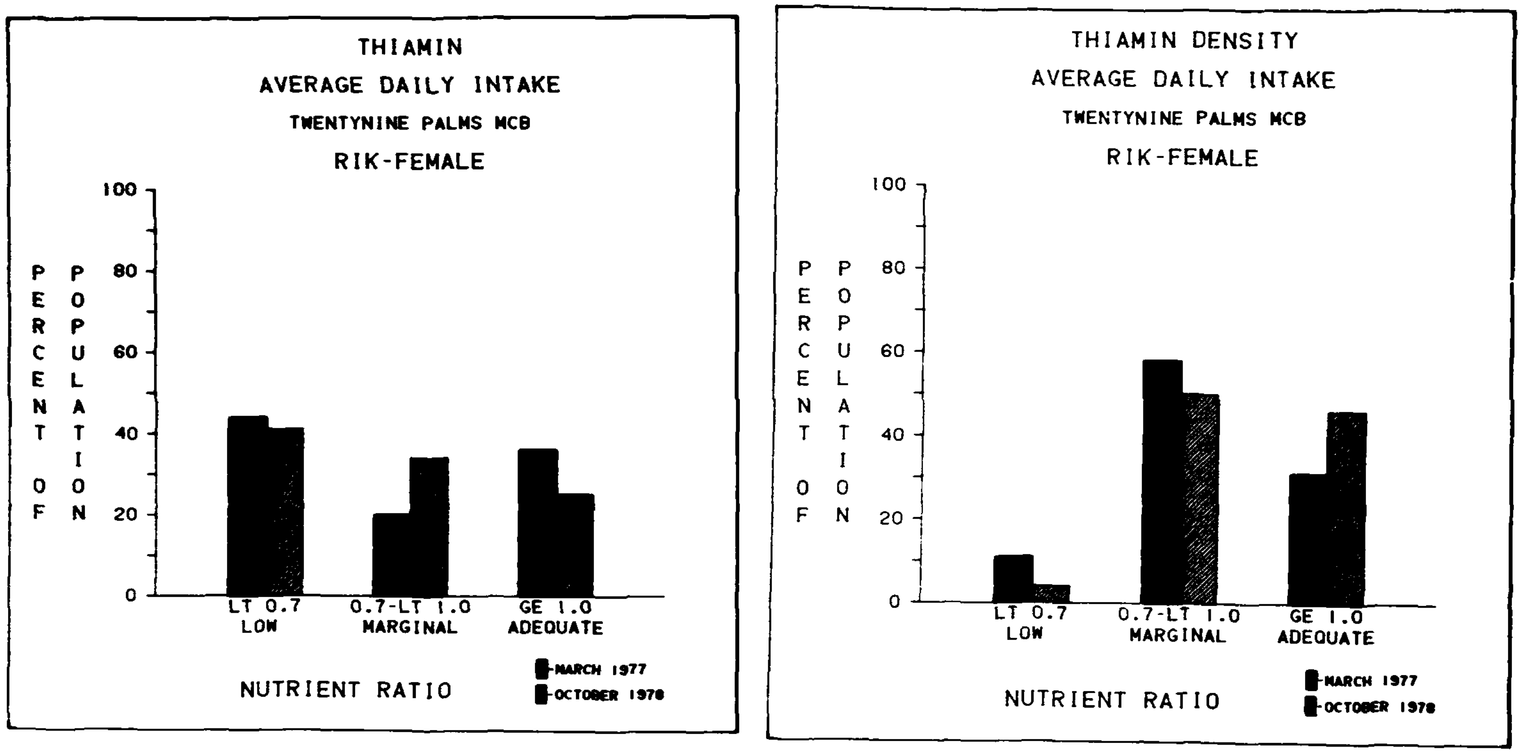


Figure 10A. RIK-Males. Distribution of Average Daily Thiamin Intake and Average Daily Thiamin Density Intake.

59-Kretsch



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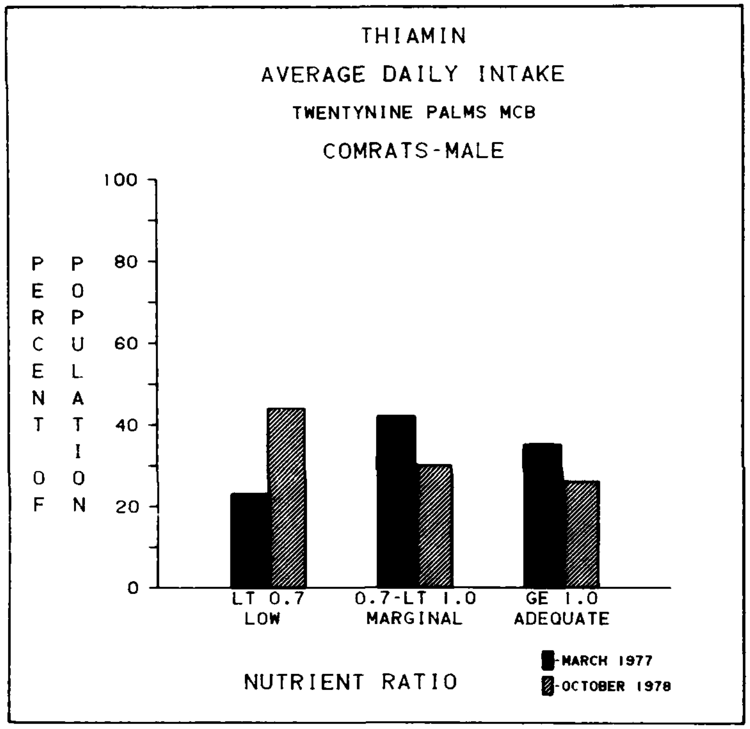


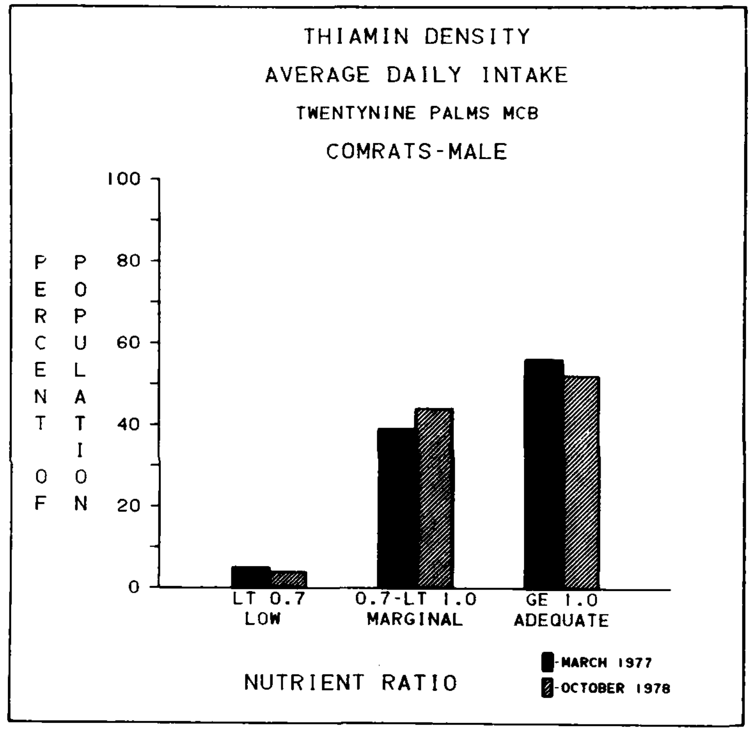
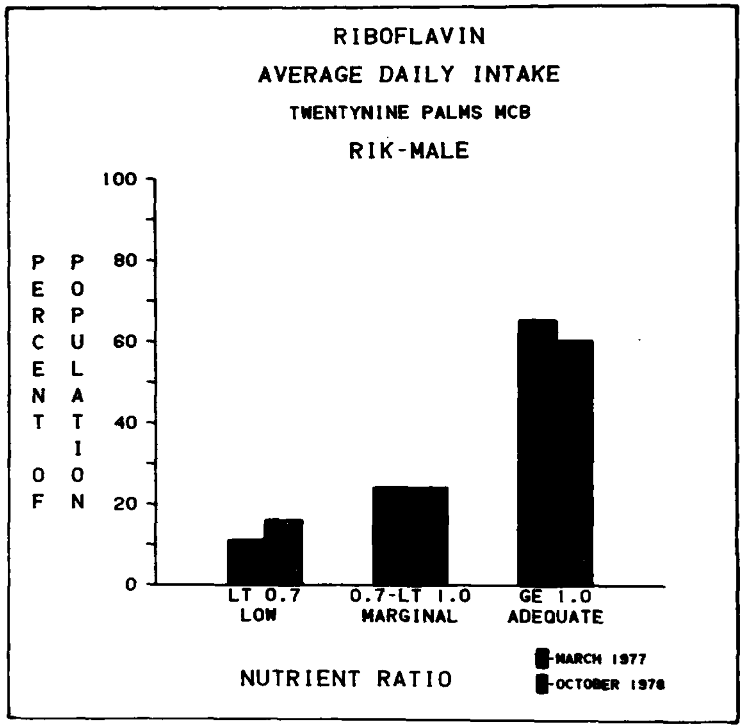


Figure 10C. COMRATS-Males. Distribution of Average Daily Thiamin Intake and Average Daily Thiamin Density Intake.



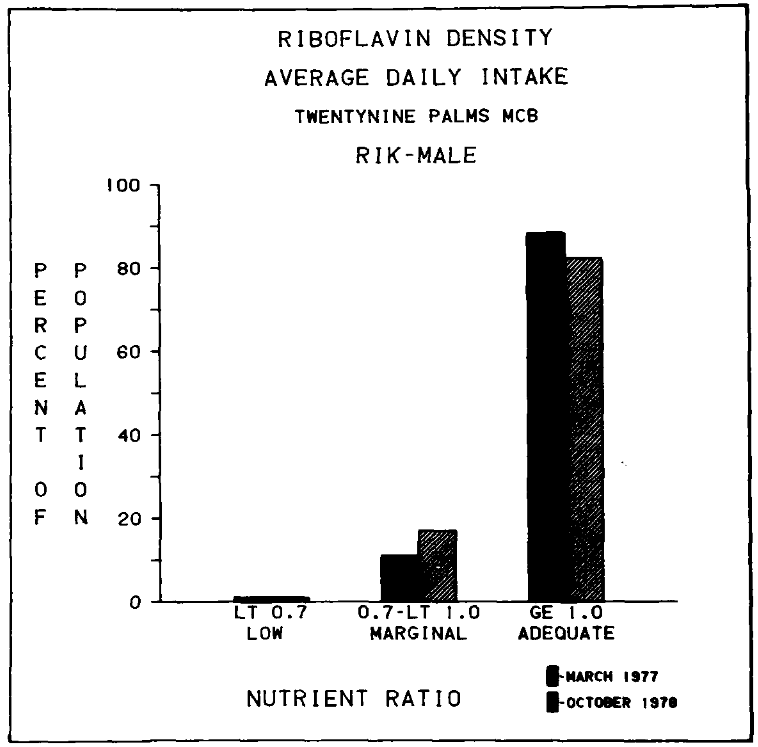
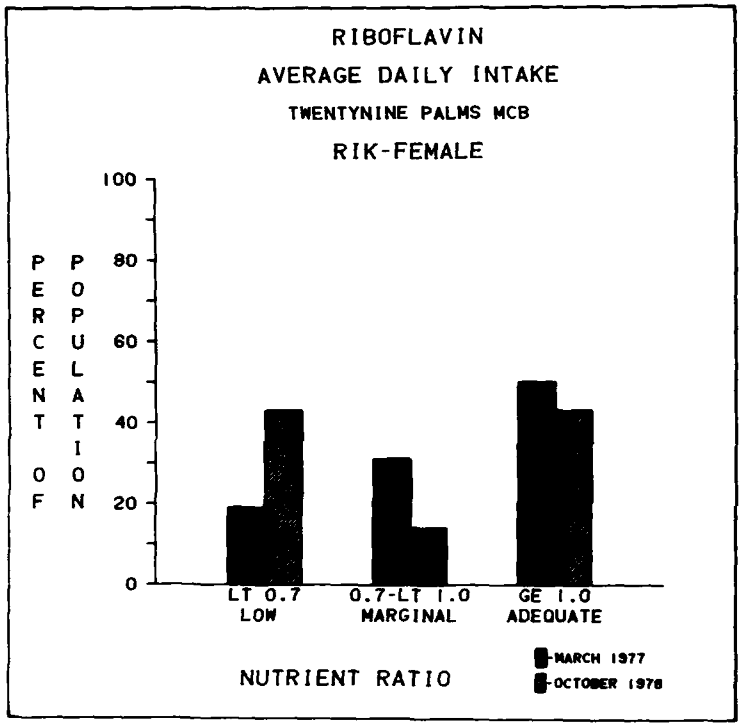


Figure 11A. RIK-Males. Distribtuion of Average Daily Riboflavin Intake and Average Daily Riboflavin Density Intake.



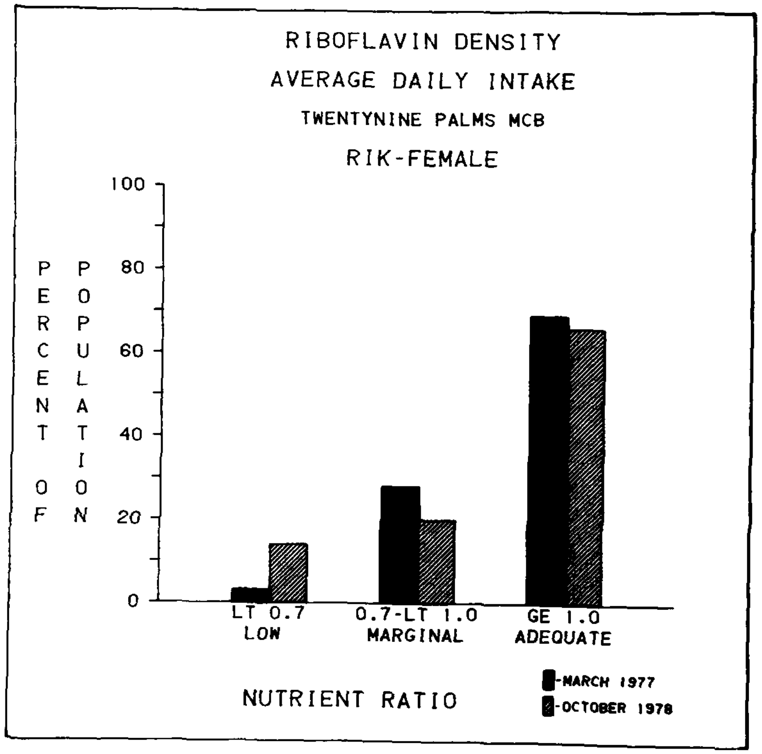


Figure 11B. RIK-Females. Distribution of Average Daily Riboflavin Intake and Average Daily Riboflavin Density Intake.

63-Kretsch

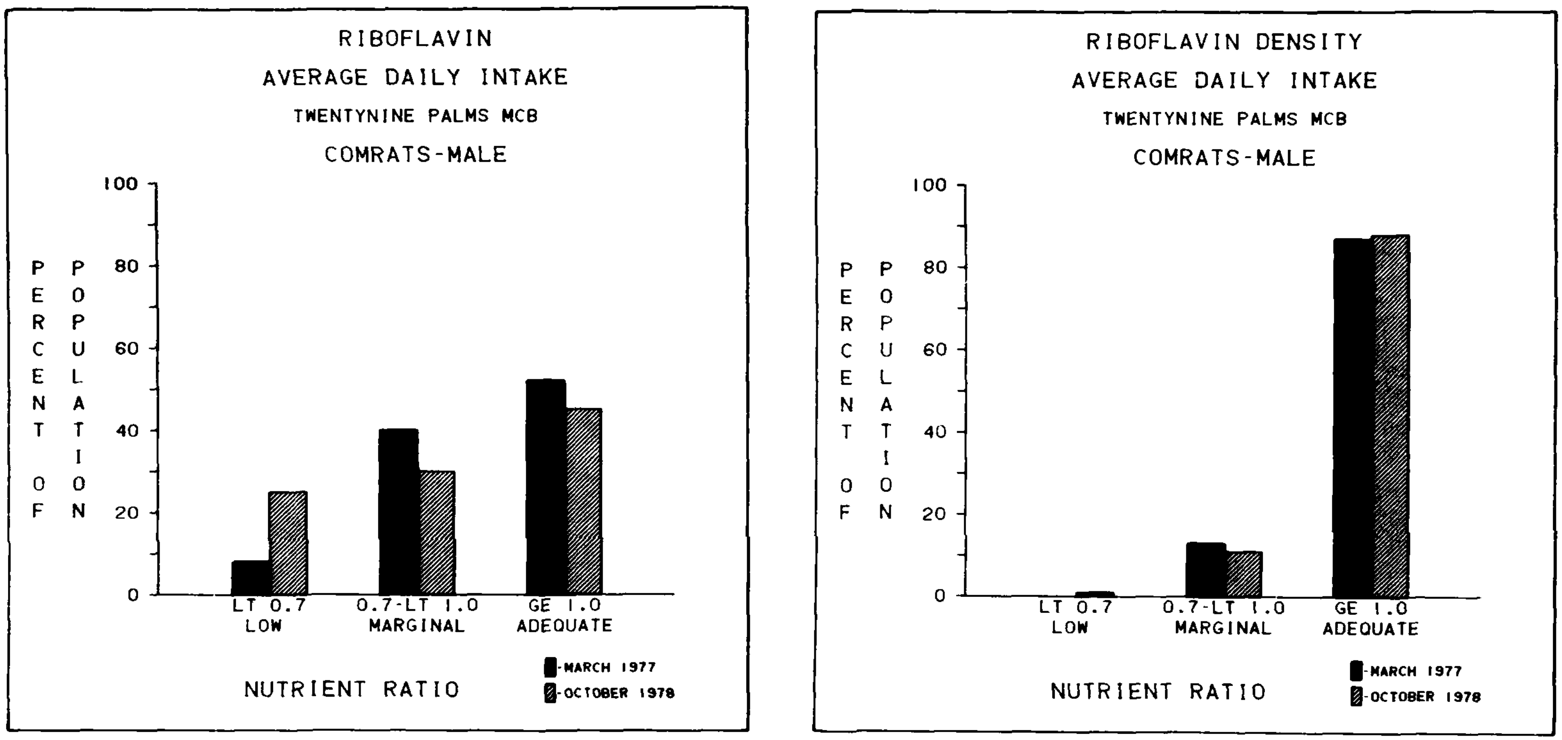


Figure 11C. COMRATS-Males. Distribution of Average Daily Riboflavin Intake and Average Daily Riboflavin Density Intake.

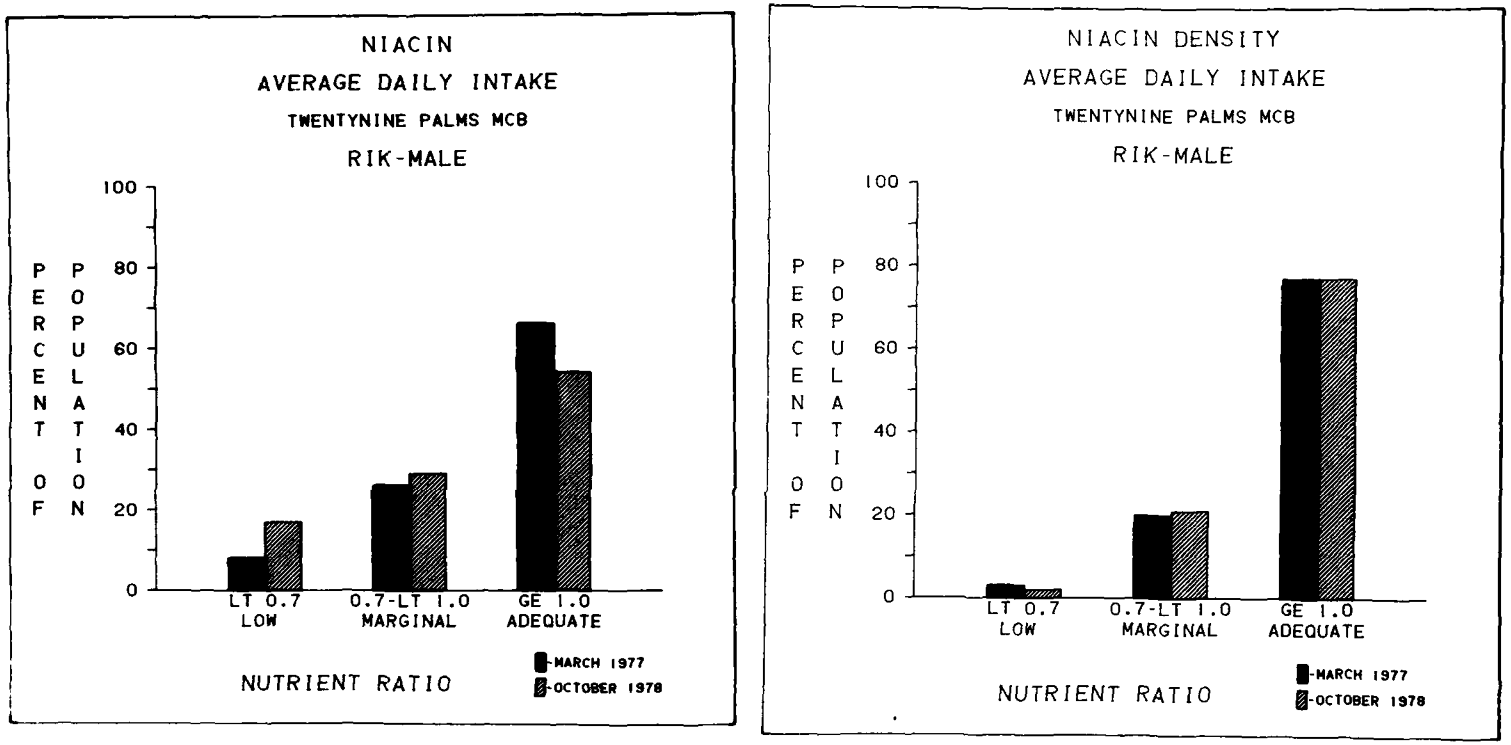
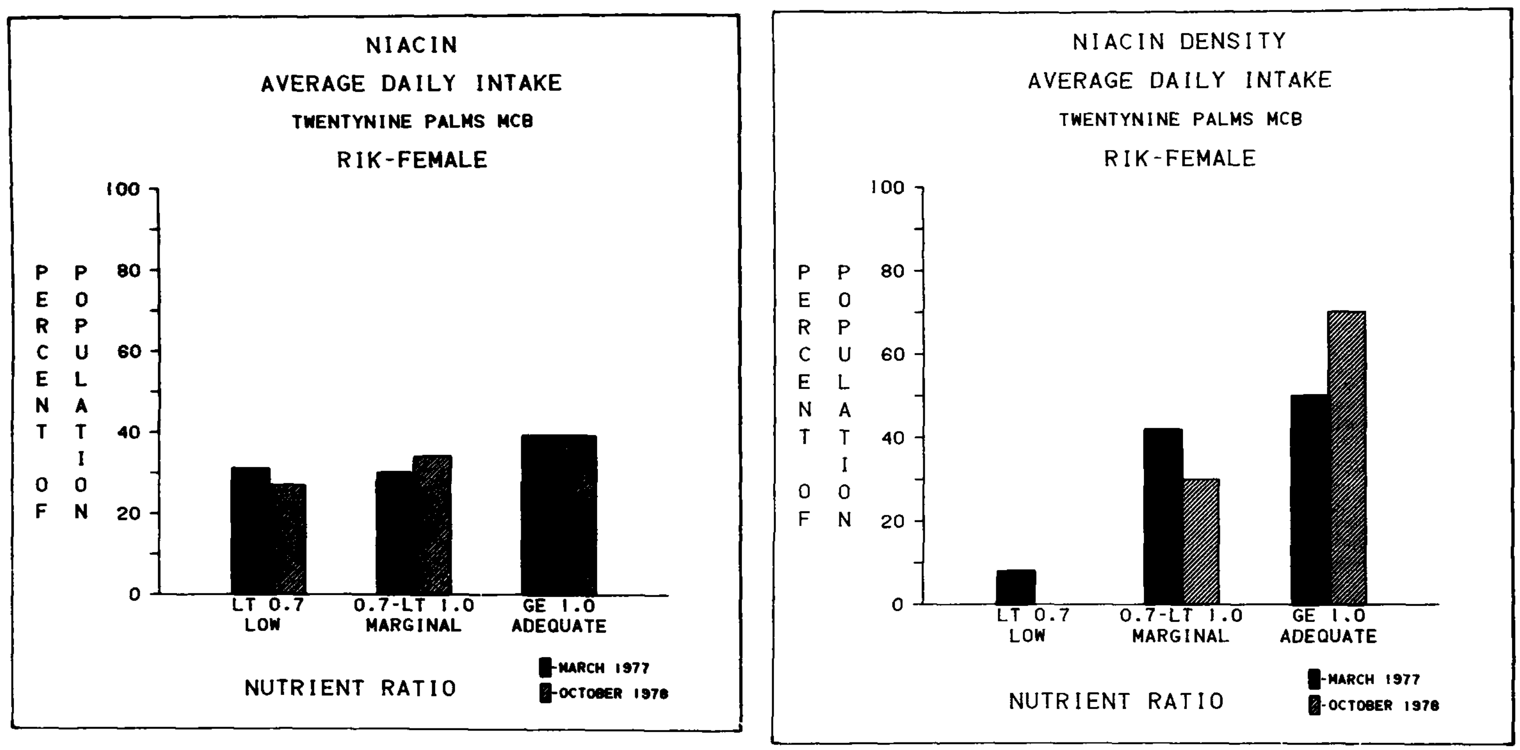


Figure 12A. RIK-Males. Distribution of Average Daily Niacin Intake and Average Daily Niacin Density Intake.

65-Kretsch



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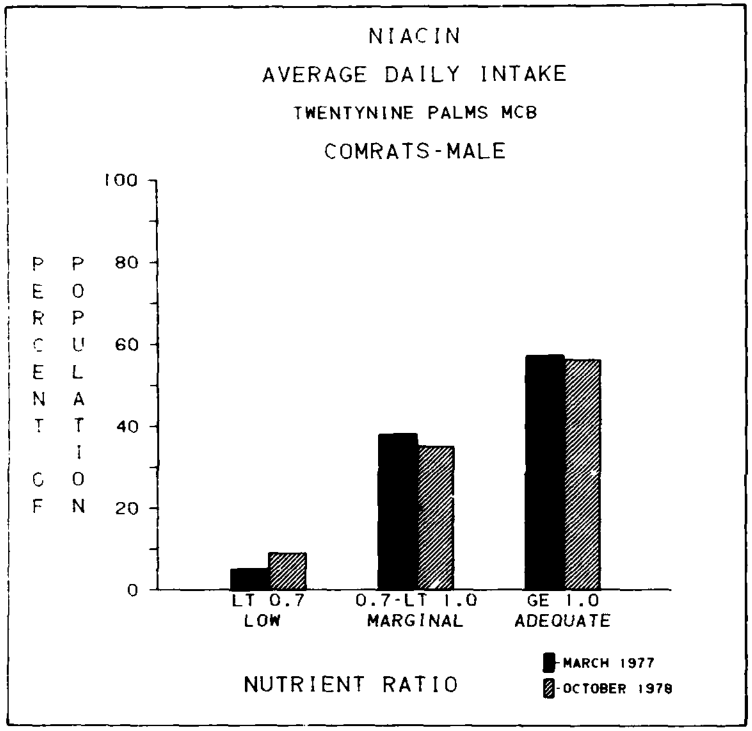


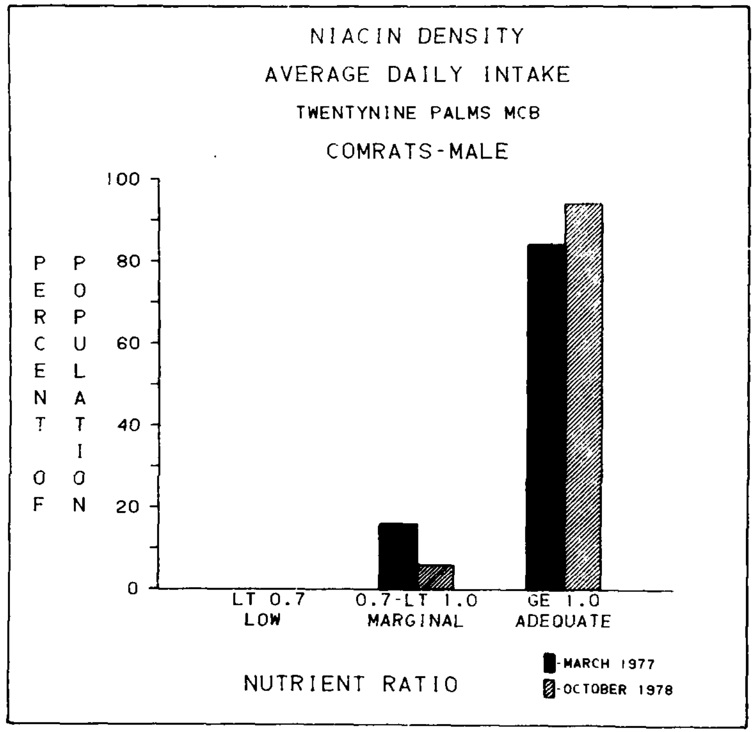


Figure 12C. COMRATS-Males. Distribution of Average Daily Niacin Intake and Average Daily Niacin Density Intake.

68-Kretsch

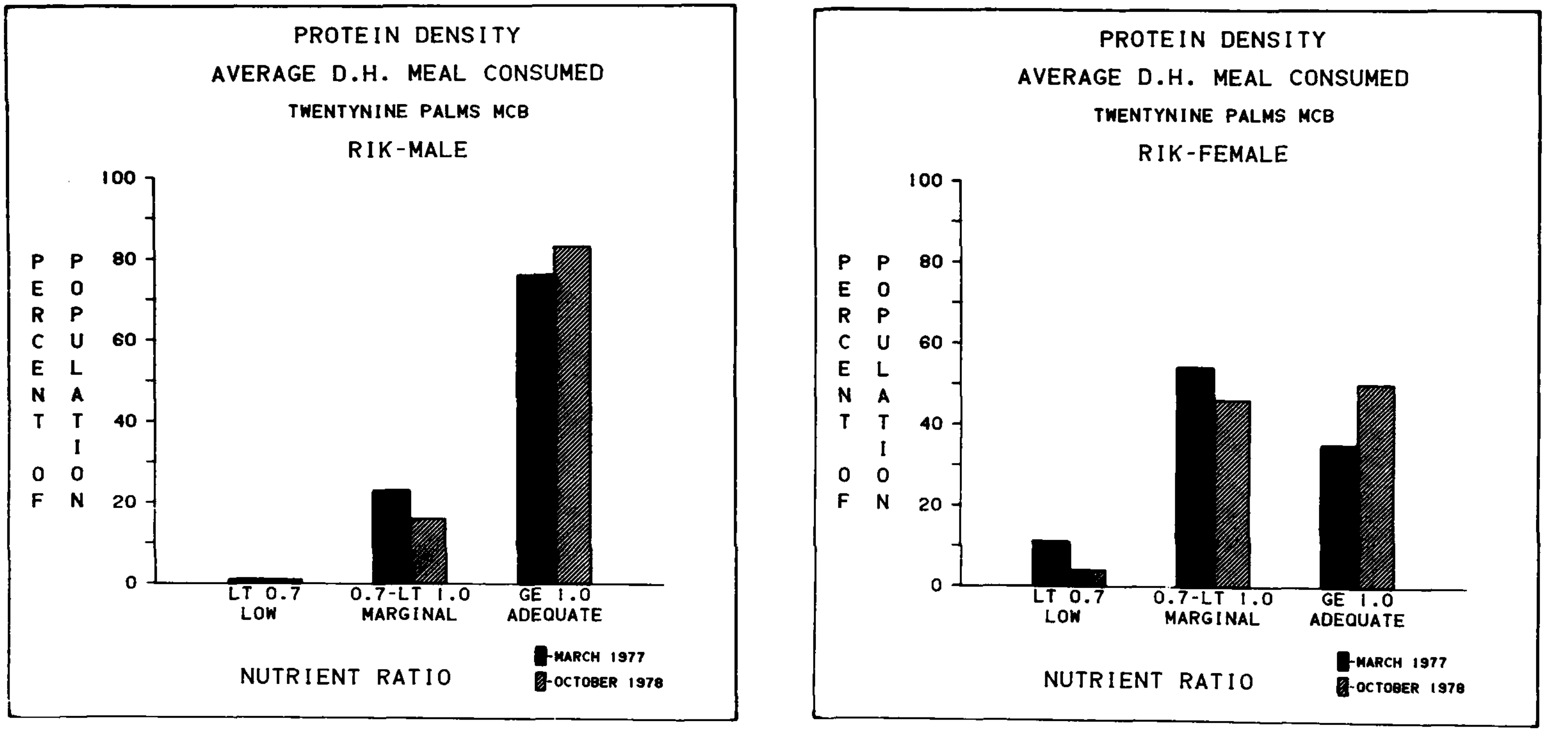


Figure 13. RIK-Males and RIK-Females. Distribution of Protein Density per Average Dining Hall Meal Consumed.

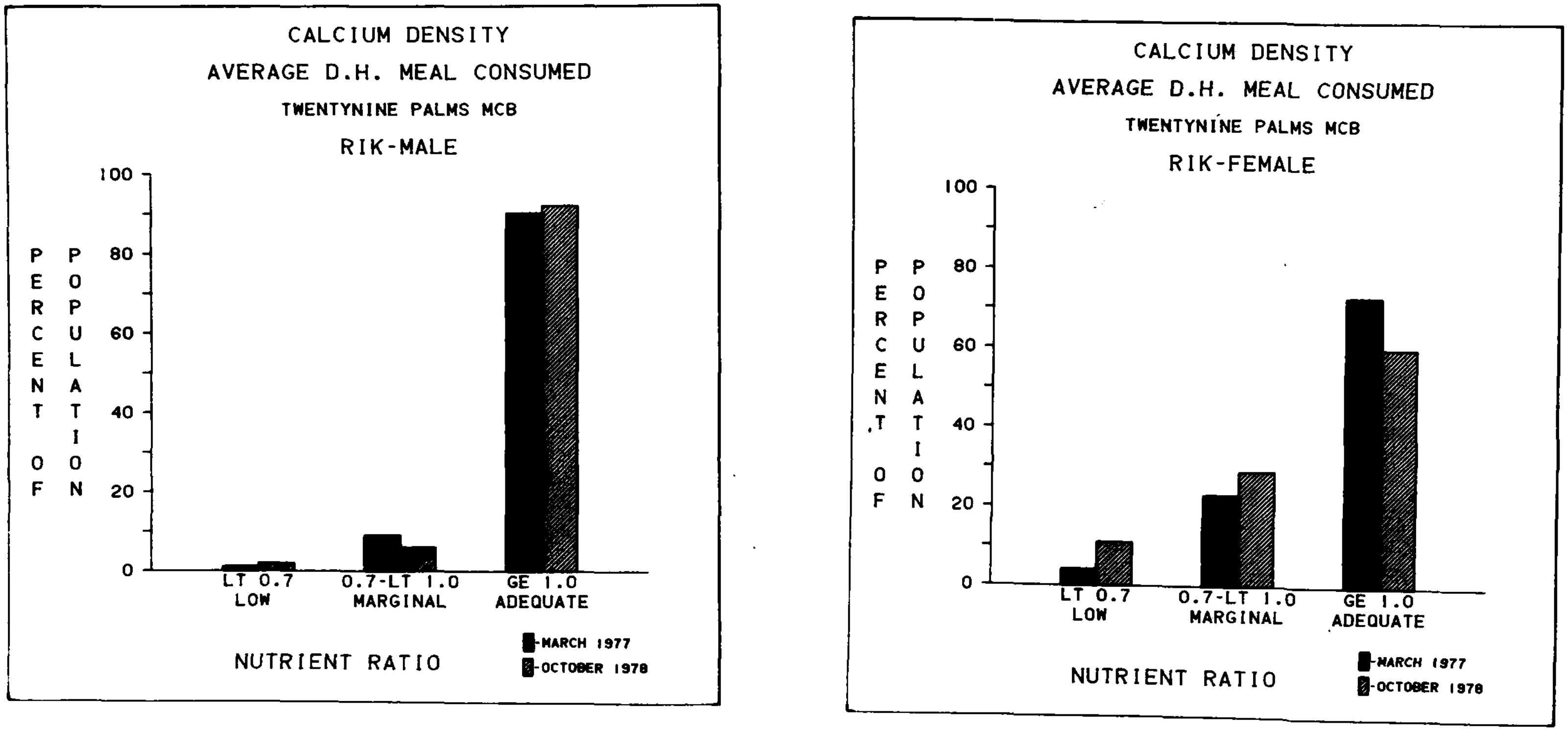


Figure 14. RIK-Males and RIK-Females. Distribution of Calcium Density per Average Dining Hall Meal Consumed.

69-Kretsch

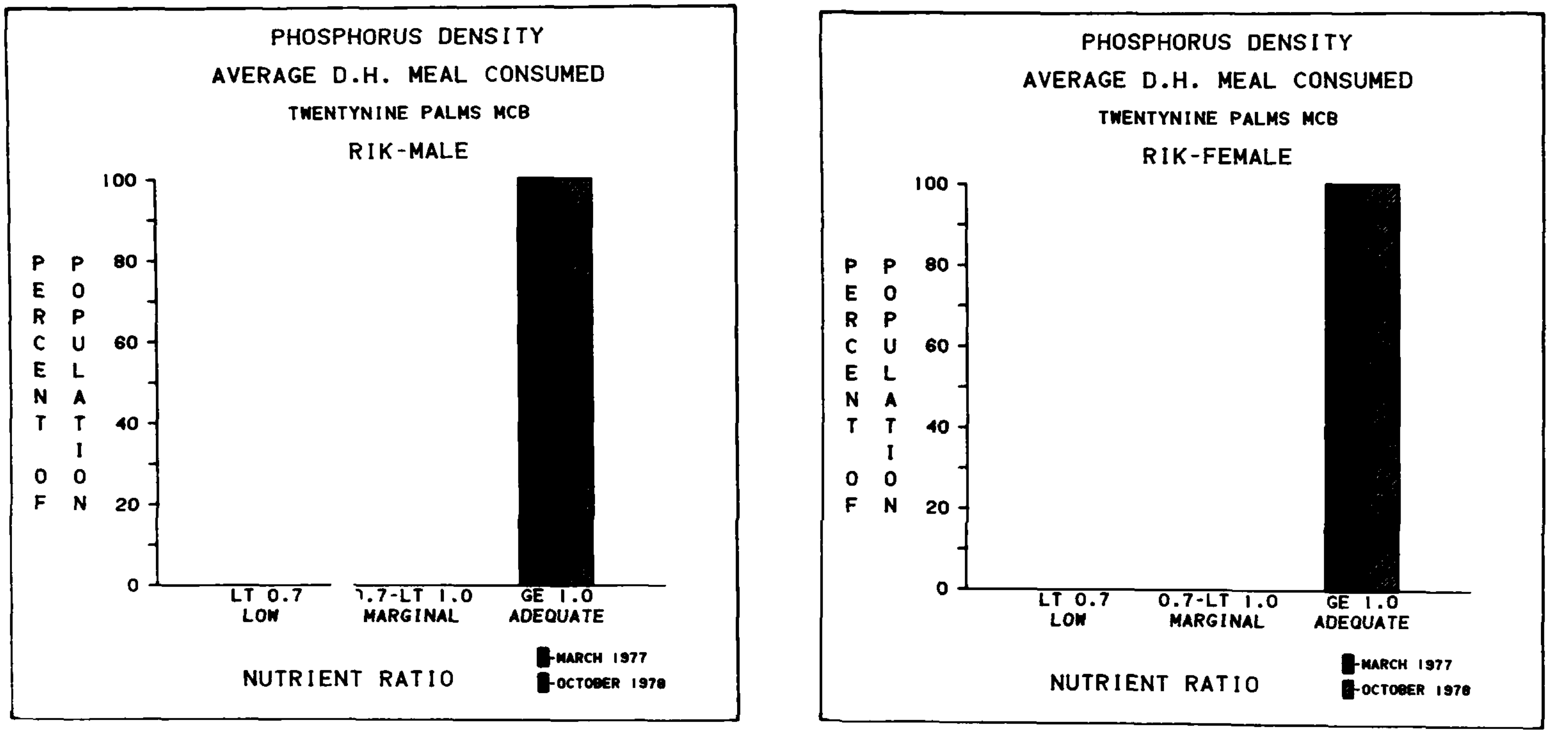
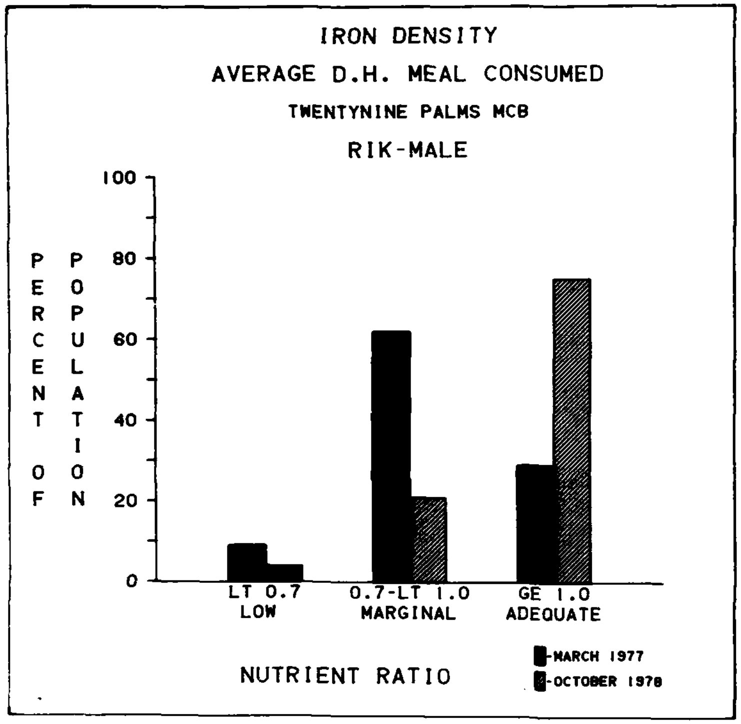


Figure 15. RIK-Males and RIK-Females. Distribution of Phosphorus Density per Average Dining Hall Meal Consumed.



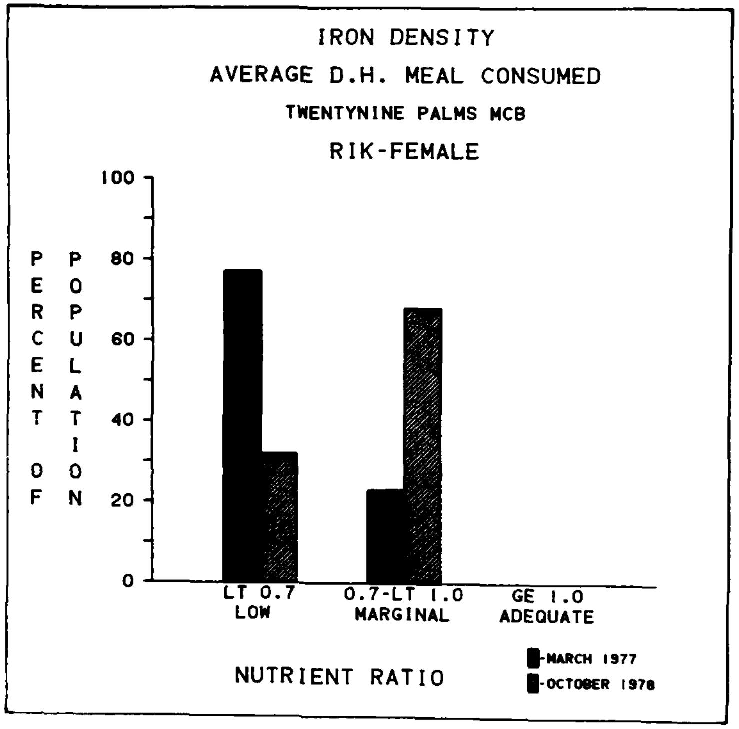


Figure 16. RIK-Males and RIK-Females. Distribution of Iron Density per Average Dining Hall Meal Consumed.

71-Kretsch

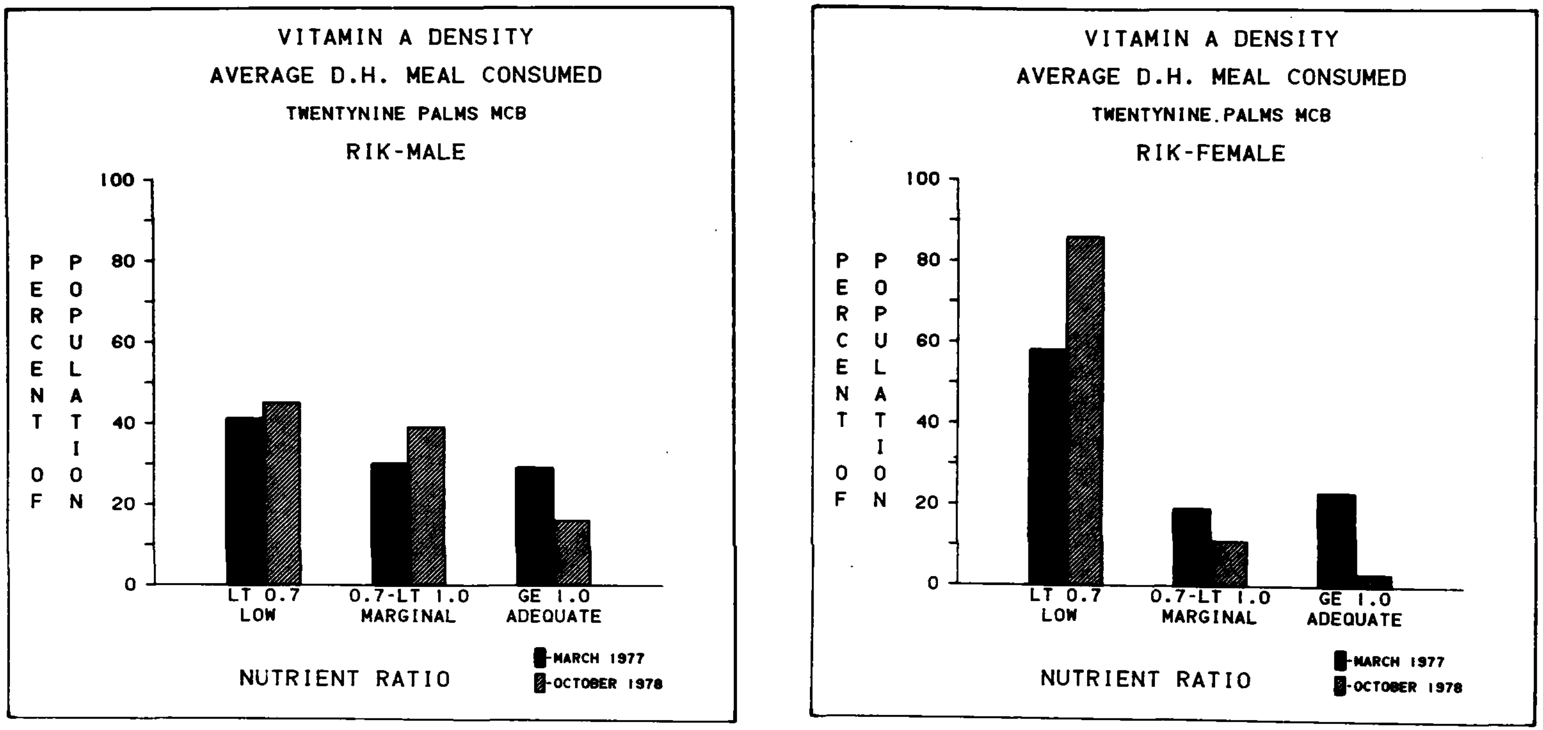
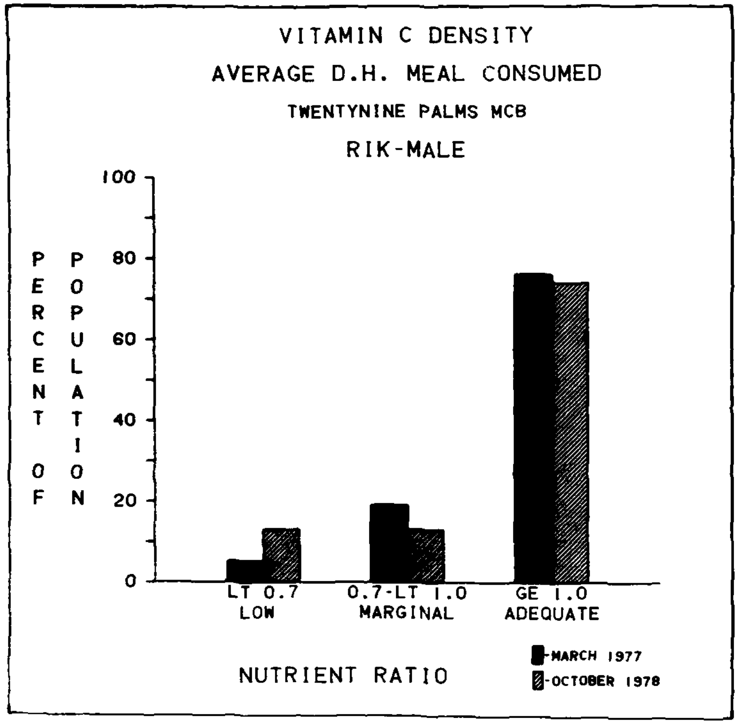


Figure 17. RIK-Males and RIK-Females. Distribution of Vitamin A Density per Average Dining Hall Meal Consumed.



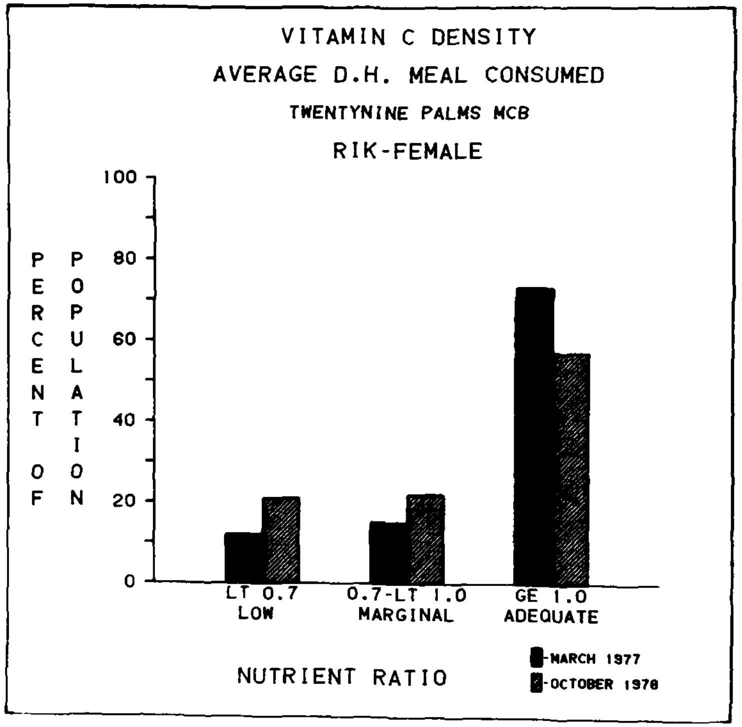
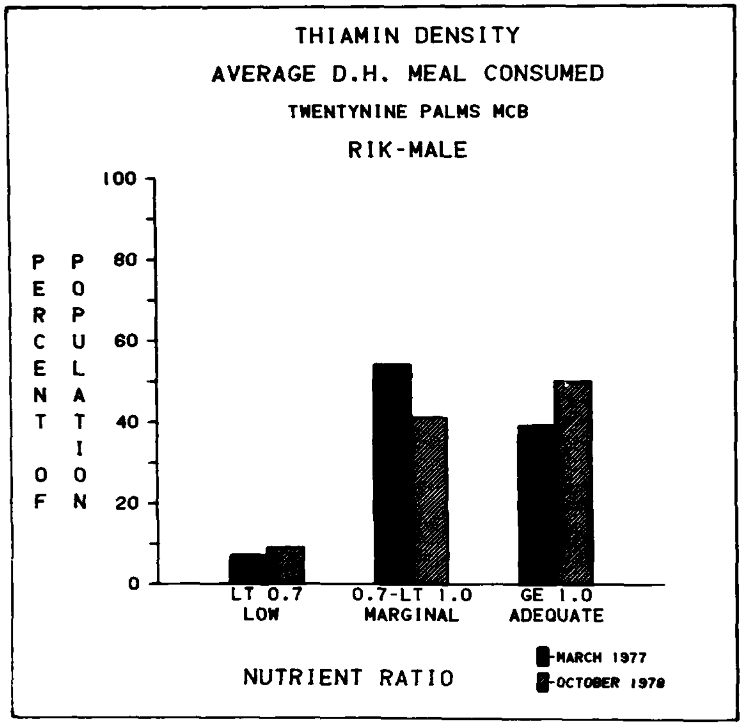


Figure 18. RIK-Males and RIK-Females. Distribution of Vitamin C Density per Average Dining Hall Meal Consumed.

73-Kretsch



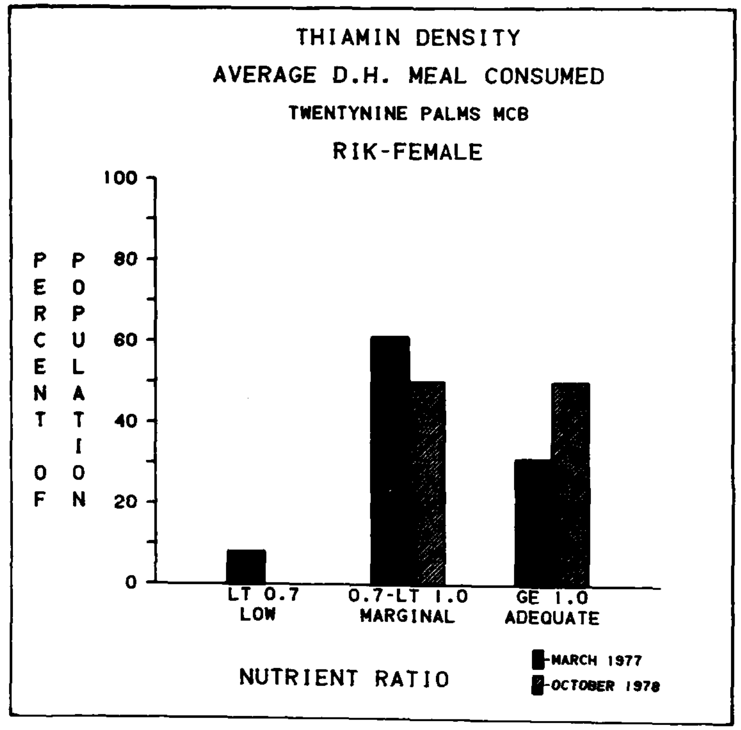


Figure 19. *RIK-Males* and *RIK-Females*. Distribution of Thiamin Density per Average Dining Hall Meal Consumed.

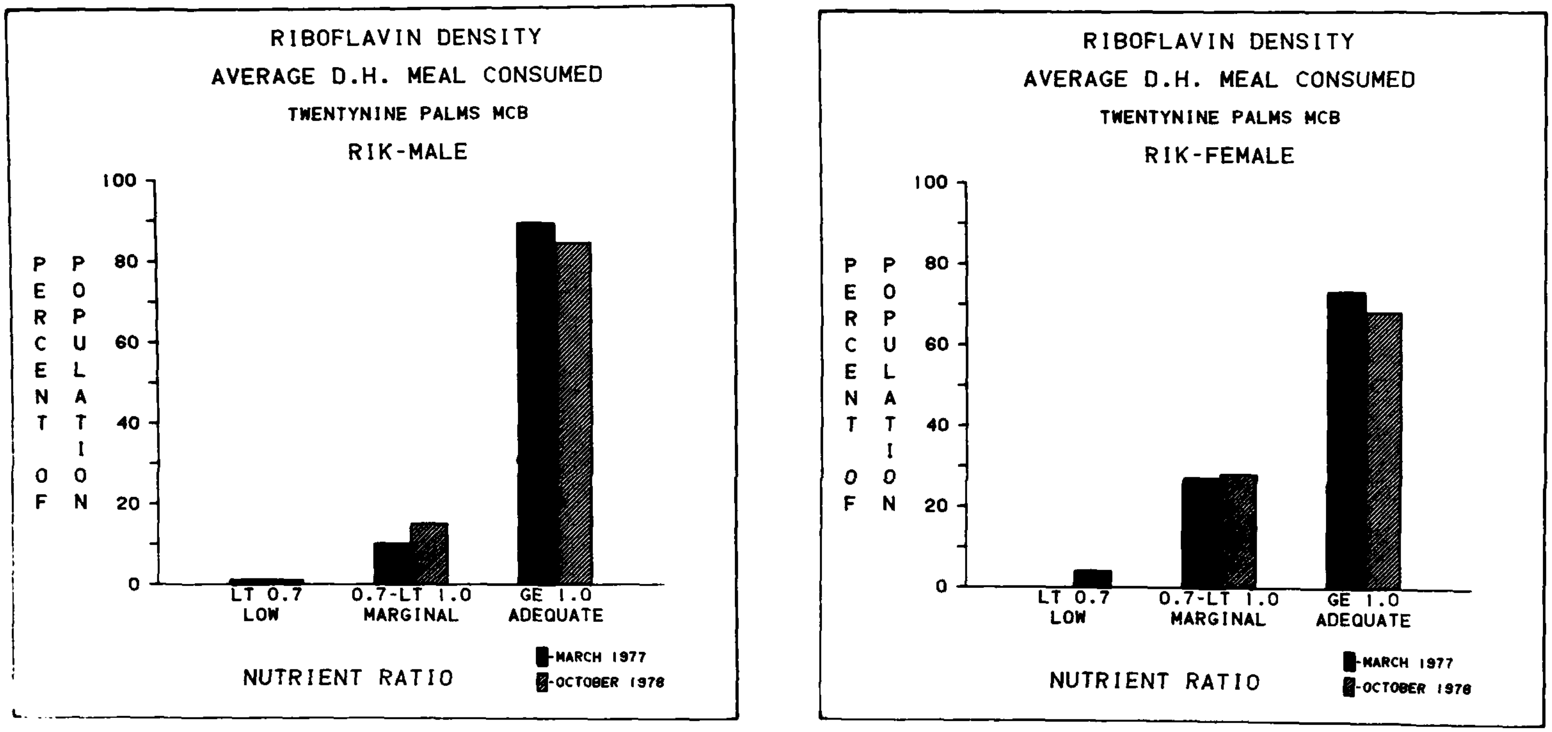


Figure 20. RIK-Males and RIK-Females. Distribution of Riboflavin Density per Average Dining Hall Meal Consumed.

75-Kretsch

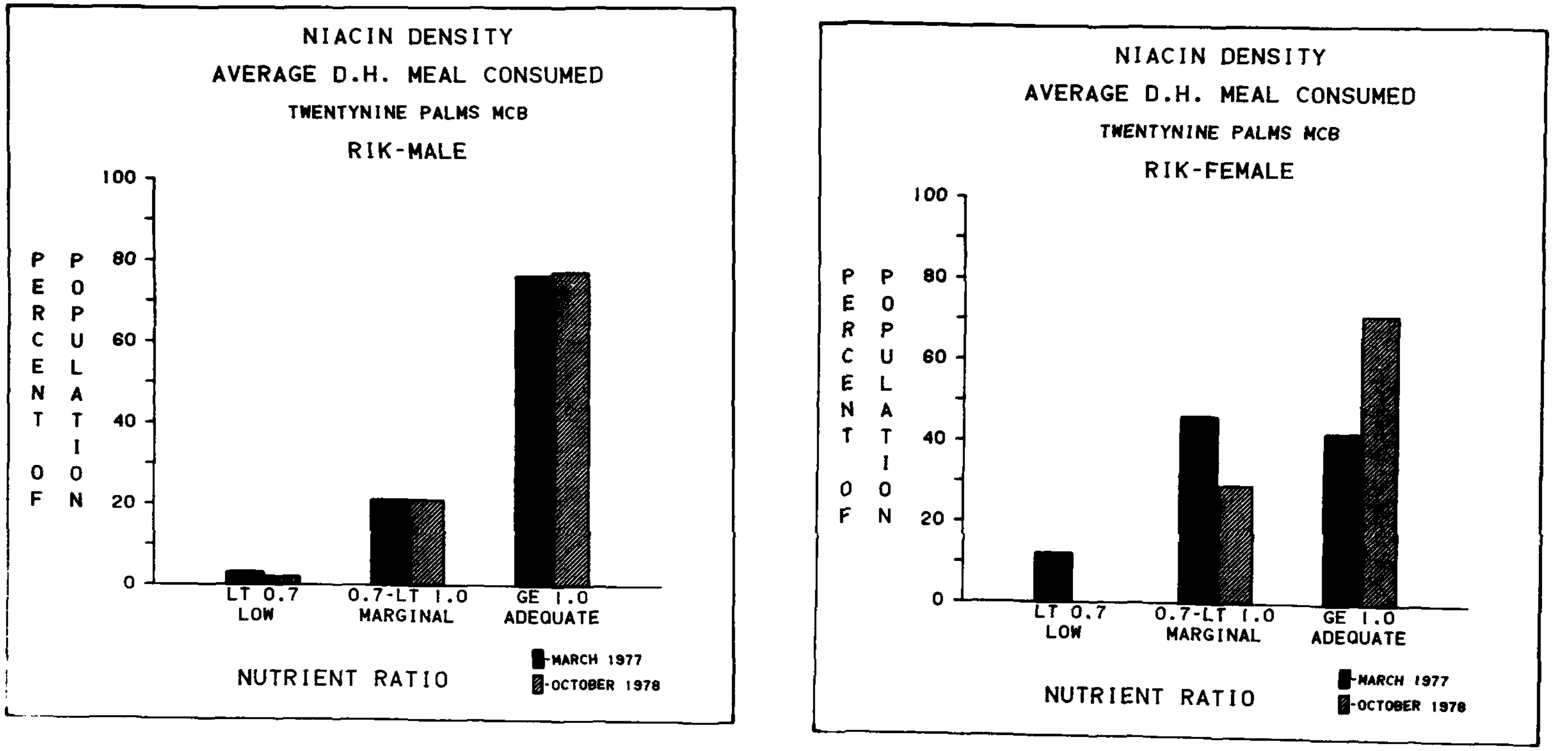


Figure 21. RIK-*Males* and RIK-Females. Distribution of Niacin Density per Average Dining Hall Meal Consumed.

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TABLE 1
GROUPS STUDIED AT TWENTYNINE PALMS MARINE CORPS BASE

RATION STATUS	UNIT(S)[1]	MARITAL STATUS	SEX	PHASE STUDIED
RIK	C&E, H&S	Single	Male	I, II
RIK	FT, FSSG	Single	Male	I, II
RIK	C&E, H&S	Single	Female	I, II
COMRATS	C&E, H&S	Married	Male	I, II
COMRATS	FT, FSSG	Married	Male	I, II
COMRATS	C&E, H&S	Single	Male	I
COMRATS	FT, FSSG	Single	Male	I

[1]C&E = Communications and Electronics school
H&S = Headquarters and Service Battalion
FT = Force Troops (Tank Battalion and Field Artillery Groups)
FSSG = Force Troops Service Support Group

TABLE 2

NUTRITIONAL STANDARDS

NUTRIENT	DAILY DIETARY NUTRIENT ALLOWANCES[1] MALE	DAILY DIETARY NUTRIENT ALLOWANCES[1] FEMALE	NUTRIENT DENSITY ALLOWANCES[2] MALE	NUTRIENT DENSITY ALLOWANCES[2] FEMALE
ENERGY (kcal)	3200	2200	...	...
PROTEIN (g)	100	80	31.2	36.4
% FAT CALORIES	<40%	<40%	<40%	<40%
CALCIUM (mg)	800	800	250	364
PHOSPHORUS (mg)	800	800	250	364
MAGNESIUM (mg)	400	300	125	136
IRON (mg)	18	18	5.6	8.2
ZINC (mg)	15	15	4.7	6.8
VITAMIN A (iu)	5000	5000	1562	2273
VITAMIN C (mg)	60	60	18.8	27.3
THIAMIN (mg)	1.6	1.1	0.5	0.5
RIBOFLAVIN (mg)	2.0	1.4	0.6	0.6
NIACIN (mg)	21	15	6.6	6.6
FOLACIN (mcg)	400	400	125	136
VITAMIN B-6 (mg)	2.0	2.0	0.6	0.9
VITAMIN B-12 (mcg)	3.0	3.0	0.9	1.4

[1]AR 40-25/BUMEDINST 1011.3E, 30 AUGUST 1976 (as corrected).

[2]Daily Dietary Nutrient Allowances expressed per 1000 Kcal.

TABLE 3
U.S. RECOMMENDED DIETARY ALLOWANCE'S
ESTIMATED SAFE AND ADEQUATE DAILY DIETARY INTAKES
OF SELECTED VITAMINS AND MINERALS[1]

SODIUM (mg)	1100-3300
POTASSIUM (mg)	1875-5625
COPPER (mg)	2.0-3.0
MANGANESE (mg)	2.5-5.0
PANTOTHENIC ACID (mg)	4-7

[1]Recommended Dietary Allowances, 9th Ed., 1980.

TABLE 4

DEMOGRAPHIC AND MEAL CONSUMPTION CHARACTERISTICS[1]

	RIK-MALES		RIK-FEMALES		COMRATS-MALES	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
NO. IN GROUP	109	120	36	44	116	91
AGE (YRS)	21.6 ± 3.8^{A}	21.2 ± 2.6^{A}	20.7 ± 1.8^{A}	21.6 ± 2.8^{A}	23.9 ± 4.8^{B}	26.0 ± 5.1^{C}
AGE RANGE	18.4 to 43.7	17.3 to 29.4	18.3 to 30.4	18.1 to 29.7	18.8 to 47.2	18.0 to 43.7
MONTHS IN SERVICE	31.7 ± 43.4^{A}	26.7 ± 19.9^{A}	15.2 ± 11.5^{A}	13.0 ± 15.7^{A}	54.1 ± 45.2^{B}	80.2 ± 62.2^{C}
MONTHS AT PRESENT POST	10.4 ± 9.0^{A}	8.7 ± 6.7^{A}	9.6 ± 7.6^{A}	8.4 ± 11.5^{A}	14.6 ± 10.6^{B}	18.4 ± 12.3^{C}
RANK (PERCENT OF GROUP)						
E1 - E3	59.7	65.1	72.3	84.1	24.2	16.4
E4 - E6	39.4	34.9	27.7	15.9	69.8	74.8
E7 - E9	0.9	0	0	0	6.0	8.8
PERCENT IN BILLETS	92.6	90.8	77.2	84.1	3.5	
TOTAL MEALS PER DAY	2.1 ± 0.4^{B}	2.0 ± 0.5^{B}	2.1 ± 0.5^{BC}	1.7 ± 0.6^{A}	2.3 ± 0.5^{C}	2.0 ± 0.4^{B}
PERCENT AVERAGE DINING HALL UTILIZATION	47.0 ± 21.4^{C}	45.5 ± 27.4^{C}	22.3 ± 23.3^{B}	17.5 ± 19.2^{B}	6.3 ± 16.6^{A}	4.4 ± 12.6^{A}

[1]Unless otherwise indicated all values are mean ± standard deviation.

^{A,B,C}Values within a row not followed by a common letter are significantly different at $P<0.05$.

TABLE 5
PERCENTAGE OF RIK GROUPS CONSUMING WEEKDAY AND WEEKEND MEALS

	C&E AND H&S MALES		FORCE TROOP MALES		FEMALES	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
WEEKDAYS						
0 MEAL/DAY	0.9	3.2	3.4	2.2	1.7	8.4
1 MEAL/DAY	15.1	24.4	19.8	20.6	22.8	31.2
2 MEAL/DAY	50.0	42.3	45.4	46.7	38.6	40.8
3 MEAL/DAY	32.8	28.8	30.2	29.2	34.4	18.8
4 MEAL/DAY	1.2	1.2	1.1	1.4	2.5	1.2
WEEKEND DAYS						
0 MEAL/DAY	4.5	2.4	3.8	1.4	2.1	10.2
1 MEAL/DAY	24.7	35.5	26.9	31.9	22.7	37.3
2 MEAL/DAY	55.3	53.9	53.8	56.9	57.4	41.3
3 MEAL/DAY	14.6	8.1	14.4	9.7	17.2	11.1
4 MEAL/DAY	0.9	0.1	1.0	0	0.7	0

TABLE 6
PERCENTAGE OF RIK GROUPS CONSUMING WEEKDAY AND WEEKEND DINING HALL MEALS[1]

	C&E AND H&S MALES		FORCE TROOP MALES		FEMALES	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
WEEKDAYS						
0 MEAL/DAY	12.1	27.4	26.5	22.5	51.1	55.6
1 MEAL/DAY	30.3	27.9	30.8	32.3	29.7	30.4
2 MEAL/DAY	40.9	27.4	33.7	27.2	13.0	11.6
3 MEAL/DAY	16.5	17.1	8.8	17.7	6.1	2.8
4 MEAL/DAY	0.2	0.3	0.2	0.3	0	0
WEEKEND DAYS						
0 MEAL/DAY	41.7	51.5	46.6	58.3	79.2	91.0
1 MEAL/DAY	33.3	28.7	29.8	22.2	15.3	8.0
2 MEAL/DAY	22.4	19.9	19.7	19.4	5.6	0
3 MEAL/DAY	2.2	0	3.4	0	0	0
4 MEAL/DAY	0	0	0.5	0	0	0

[1]Three meals per weekday and two per weekend day were served at the dining hall.

TABLE 7
ANTHROPOMETRIC CHARACTERISTICS[1]

	RIK-MALES		RIK-FEMALES		COMRATS-MALES	
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II
HEIGHT (CM)	177.2 ± 7.5^{B}	174.9 ± 6.6^{B}	167.5 ± 7.4^{A}	165.4 ± 6.7^{A}	176.5 ± 6.9^{B}	176.8 ± 7.4^{B}
WEIGHT (KG)	73.1 ± 9.0^{BC}	71.9 ± 10.0^{B}	60.1 ± 8.4^{A}	60.9 ± 7.4^{A}	75.4 ± 11.4^{CD}	78.1 ± 10.1^{D}
WEIGHT FOR HEIGHT (% OF GROUP)						
UNDERWEIGHT	0	0	0	6.8	0	0
WITHIN STANDARDS	94.5	89.2	91.7	61.4	87.1	79.1
OVERWEIGHT	5.5	10.8	8.3	31.8	12.9	20.9
WEIGHT CHANGE OVER STUDY PERIOD						
MEAN ± S.D.	...	+0.3 ± 1.3	...[2]	-0.3 ± 1.5	...	-0.1 ± 1.8
RANGE	...	-3.6 to +5.1	...	-6.0 to +2.3	...	-9.9 to +4.9
PERCENT BODY FAT						
DURNIN & WOMSERLEY	...	15.5 ± 4.3^{A}	...	27.4 ± 4.2^{C}	...	18.4 ± 4.5^{B}
CHINN & ALLEN	12.7 ± 4.3^{A}	12.4 ± 3.4^{A}	...	...	14.5 ± 3.9^{B}	15.5 ± 3.7^{B}
SKINFOLDS (MM)						
R. BICEP	...	4.2 ± 1.9^{A}	...	7.7 ± 3.2^{C}	...	5.0 ± 2.2^{B}
L. BICEP	...	4.3 ± 2.0^{A}	...	7.9 ± 3.1^{C}	...	5.2 ± 2.4^{B}
R. TRICEP	9.3 ± 3.7^{A}	8.6 ± 3.6^{A}	14.8 ± 4.6^{B}	16.4 ± 4.3^{B}	9.2 ± 3.8^{A}	9.7 ± 4.3^{A}
L. TRICEP	9.3 ± 3.8^{A}	8.5 ± 3.4^{A}	14.7 ± 4.7^{B}	16.4 ± 4.3^{B}	9.3 ± 3.7^{A}	9.7 ± 4.5^{A}
R. SUBSCAPULA	11.0 ± 3.6^{AB}	10.7 ± 3.9^{A}	10.8 ± 3.5^{AB}	13.6 ± 5.7^{C}	12.2 ± 4.2^{BC}	12.9 ± 4.5^{BC}
L. SUBSCAPULA	11.2 ± 3.6^{A}	10.9 ± 3.0^{A}	11.4 ± 3.5^{AB}	13.8 ± 5.6^{B}	12.7 ± 4.4^{B}	13.7 ± 5.0^{B}
R. SUPRA-ILIAC	...	16.1 ± 7.4^{A}	...	17.1 ± 6.0^{A}	...	20.2 ± 8.3^{B}
L. SUPRA-ILIAC	...	16.8 ± 7.7^{A}	...	17.2 ± 6.5^{A}	...	21.0 ± 8.9^{B}

[1] All values are mean ± standard deviation unless otherwise indicated.
[2] ... indicates that measurement not taken.
A,B,C,D Values within a row not followed by a common letter are significantly different at $P<0.005$.

TABLE 8
ESTIMATED PERCENTAGE OF BODY FAT IN MALE MARINES[1]
(CHINN AND ALLEN EQUATION)

AGE GROUP	Phase I n	Phase I % Fat	Phase II n	Phase II % Fat
17-19	55	11.7 ± 4.2	43	11.1 ± 3.9
20-24	131	13.1 ± 3.5	115	13.5 ± 3.7
25-29	22	16.3 ± 3.4	36	15.9 ± 3.5
30-34	11	17.2 ± 4.2	11	14.8 ± 2.6
35-39	3	20.6 ± 1.1	4	20.6 ± 0.7
40-50	3	23.3 ± 0.8	2	19.4 ± 1.1

[1]RIK and COMRATS males combined. Values are mean ± standard deviation.

TABLE 9
PHASE II ESTIMATED PERCENTAGE OF BODY FAT IN MALE AND FEMALE MARINES[1]
(DURNIN AND WOMSERLEY EQUATION)

AGE GROUP	RIK & COMRATS MALES n	RIK & COMRATS MALES % Fat	RIK FEMALES n	RIK FEMALES % Fat
17-19	43	16.0 ± 4.5	15	26.8 ± 5.3
20-24	115	16.6 ± 4.6	23	26.7 ± 4.4
25-29	36	17.7 ± 4.7	6	30.1 ± 3.7
30-34	11	17.9 ± 3.9	0	...
35-39	4	24.1 ± 0.6	0	...
40-50	2	19.3 ± 3.8	0	...

[1]Mean ± standard deviation.

TABLE 10

PERCENTAGE OF MARINES REGULARLY CONSUMING NUTRIENT SUPPLEMENTS

	Multi-Vitamin	Multi-Mineral	Vitamin B-Complex	Vitamin C	Vitamin E	Iron
29 PALMS -PHASE I						
COMRATS-Male	24.1	2.3	0	6.8	5.3	14.3
RIK-Male	11.2	1.7	0.9	4.3	1.7	4.3
RIK-Female	15.8	5.3	7.9	7.9	5.3	7.9
29 PALMS - PHASE II						
COMRATS-Male	25.6	6.4	9.0	15.4	11.5	10.3
RIK-Male	7.6	2.1	2.8	8.3	9.7	3.4
RIK-Female	23.3	9.3	11.6	11.6	9.3	18.6

TABLE 11A
AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]
RIK-MALES

	C&E and H&S PERSONNEL		FORCE TROOPS PERSONNEL	
	Phase I	Phase II	Phase I	Phase II
QUANTITY (g)	3044 ± 977^{A}	2785 ± 1061^{A}	2833 ± 1034^{A}	2789 ± 976^{A}
ENERGY (kcal)	3321 ± 747^{B}	$\underline{2865} \pm 849^{A}$	$\underline{2827} \pm 816^{A}$	$\underline{2800} \pm 690^{A}$
PROTEIN (g)	116 ± 30^{B}	101 ± 33^{A}	99 ± 31^{A}	105 ± 28^{BA}
FAT (g)	142 ± 37^{B}	119 ± 42^{A}	116 ± 41^{A}	119 ± 34^{A}
CARBOHYDRATE (g)	344 ± 89^{B}	301 ± 105^{A}	283 ± 86^{A}	293 ± 84^{A}
ALCOHOL (g)	27 ± 32^{A}	31 ± 36^{A}	33 ± 44^{A}	23 ± 25^{A}
CRUDE FIBER (g)	4.0 ± 1.6^{B}	3.1 ± 1.4^{A}	3.4 ± 1.4^{A}	3.1 ± 1.6^{A}
CHOLESTEROL (mg)	667 ± 289^{B}	497 ± 232^{A}	570 ± 272^{AB}	523 ± 219^{A}
CALCIUM (mg)	1469 ± 554^{B}	1104 ± 527^{A}	1084 ± 523^{A}	1184 ± 474^{A}
PHOSPHORUS (mg)	2126 ± 559^{B}	1777 ± 622^{A}	1732 ± 619^{A}	1862 ± 538^{A}
MAGNESIUM (mg)[2]	$\underline{329} \pm 114^{C}$	$\underline{215} \pm 75^{A}$	$\underline{278} \pm 112^{B}$	$\underline{213} \pm 77^{A}$
SODIUM (mg)	3786 ± 1048^{B}	3337 ± 1241^{A}	3075 ± 1172^{A}	3231 ± 901^{A}
POTASSIUM (mg)	3843 ± 1007^{B}	3218 ± 1088^{A}	3198 ± 1136^{A}	3190 ± 1065^{A}
IRON (mg)	16.3 ± 4.8^{B}	16.8 ± 5.2^{B}	14.0 ± 4.2^{A}	16.6 ± 4.1^{B}
ZINC (mg)[2]	16.5 ± 4.7^{B}	$\underline{14.1} \pm 5.5^{A}$	$\underline{14.7} \pm 5.0^{BA}$	$\underline{13.8} \pm 4.3^{A}$
COPPER (mg)[2]	1.66 ± 0.77^{B}	$\underline{1.22} \pm 0.50^{A}$	$\underline{1.61} \pm 0.69^{B}$	$\underline{1.21} \pm 0.48^{A}$
MANGANESE (mg)[2]	1.33 ± 0.52^{A}	1.31 ± 0.81^{A}	1.34 ± 0.61^{A}	1.22 ± 0.51^{A}

[1]Values are Mean $\pm$ S.D. Underlined values are below military nutritional standard. Values within a row not followed by common letter are significantly different at $P<0.05$.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 11B
AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]
RIK-MALES

	C&E AND H&S PERSONNEL		FORCE TROOPS PERSONNEL	
	Phase I	Phase II	Phase I	Phase II
VITAMIN A (IU)	5624 ± 4472^{B}	$\underline{3741} \pm 2131^{A}$	$\underline{4097} \pm 3629^{AB}$	$\underline{4012} \pm 4574^{AB}$
VITAMIN C (MG)	99 ± 58^{AB}	$\underline{115} \pm 76^{B}$	$\underline{82} \pm 47^{A}$	$\underline{81} \pm 61^{A}$
THIAMIN (MG)	1.63 ± 0.46^{B}	$\underline{1.42} \pm 0.55^{AB}$	$\underline{1.29} \pm 0.55^{A}$	$\underline{1.42} \pm 0.46^{AB}$
RIBOFLAVIN (MG)	2.80 ± 0.89^{B}	$\underline{2.16} \pm 0.86^{A}$	$\underline{2.21} \pm 0.87^{A}$	$\underline{2.38} \pm 0.83^{A}$
NIACIN (MG)	25.0 ± 8.0^{A}	21.6 ± 6.9^{A}	22.7 ± 6.5^{A}	21.8 ± 6.7^{A}
VITAMIN B-6 (MG)[2]	$\underline{1.91} \pm 0.75^{B}$	$\underline{1.57} \pm 0.70^{B}$	$\underline{1.75} \pm 0.71^{AB}$	$\underline{1.56} \pm 0.61^{A}$
FOLIC ACID (MCG)[2]	$\underline{197} \pm 78^{B}$	$\underline{139} \pm 69^{A}$	$\underline{166} \pm 78^{A}$	$\underline{140} \pm 80^{A}$
VITAMIN B-12 (MCG)[2]	6.95 ± 6.84^{B}	3.90 ± 2.47^{A}	4.79 ± 5.38^{AB}	5.21 ± 6.30^{AB}
PANTOTHENIC ACID (MG)[2]	5.9 ± 2.1^{C}	4.0 ± 1.8^{A}	4.8 ± 2.1^{B}	4.3 ± 1.8^{AB}

[1]Values are Mean $\pm$ S.D. Underlined values are below the military standard. Values within a row not followed by a common letter are significantly different at $P<0.05$.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 12A
AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]
RIK - FEMALES

	Phase I	Phase II
QUANTITY (g)	1840 ± 773^{A}	1719 ± 550^{A}
ENERGY (kcal)	<u>2037</u> ± 754^{A}	<u>1774</u> ± 608^{A}
PROTEIN (g)	<u>72</u> ± 29^{A}	<u>63</u> ± 22^{A}
FAT (g)	92 ± 38^{B}	75 ± 30^{A}
CARBOHYDRATE (g)	224 ± 95^{A}	201 ± 70^{A}
ALCOHOL (g)	6 ± 9^{A}	9 ± 12^{A}
CRUDE FIBER (g)	2.5 ± 1.2^{A}	2.4 ± 1.9^{A}
CHOLESTEROL (mg)	369 ± 172^{B}	285 ± 151^{A}
CALCIUM (mg)	927 ± 598^{B}	<u>664</u> ± 314^{A}
PHOSPHORUS (mg)	1269 ± 555^{B}	1060 ± 385^{A}
MAGNESIUM (mg)[2]	<u>188</u> ± 73^{B}	<u>144</u> ± 55^{A}
SODIUM (mg)	2140 ± 903^{A}	2184 ± 812^{A}
POTASSIUM (mg)	2207 ± 890^{A}	1926 ± 799^{A}
IRON (mg)	<u>10.3</u> ± 3.9^{A}	<u>11.4</u> ± 3.6^{A}
ZINC (mg)[2]	<u>10.1</u> ± 4.3^{B}	<u>8.0</u> ± 3.5^{A}
COPPER (mg)[2]	0.88 ± 0.45^{A}	0.74 ± 0.29^{A}
MANGANESE (mg)[2]	1.01 ± 0.61^{A}	0.92 ± 0.58^{A}

[1]Values are Mean ± S.D. Underlined values are below the military nutritional standard. Values, within a row, not followed by a common letter are significantly different at $P<0.05$.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 12B
AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]
RIK-FEMALES

	Phase I	Phase II
VITAMIN A (IU)	4182 ± 4412[A]	2831 ± 5335[A]
VITAMIN C (mg)	74.4 ± 42.5[A]	68.7 ± 56.5[A]
THIAMIN (mg)	0.92 ± 0.36[A]	0.87 ± 0.34[A]
RIBOFLAVIN (mg)	1.56 ± 0.87[B]	1.23 ± 0.55[A]
NIACIN (mg)	13.8 ± 6.0[A]	13.9 ± 5.4[A]
VITAMIN B-6 (mg)[2]	0.92 ± .35[A]	0.73 ± .36[A]
FOLIC ACID (mcg)[2]	139 ± 62[B]	93 ± 52[A]
VITAMIN B-12 (mcg)[2]	3.98 ± 5.85[A]	2.08 ± 1.20[A]
PANTOTHENIC ACID (mg)[2]	3.2 ± 1.6[B]	2.3 ± 1.3[A]

[1]Values are Mean ± SD. Underlined values are below the military nutritional standard. Values within a row not followed by a common letter are significantly different at P<0.05.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 13A

AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]

COMRATS-MALES

	C&E and H&S PERSONNEL		FORCE TROOPS PERSONNEL	
	Phase I	Phase II	Phase I	Phase II
QUANTITY (GM)	2639 ± 956^{A}	2586 ± 1006^{A}	2694 ± 935^{A}	2908 ± 985^{A}
ENERGY (KCAL)	2731 ± 753^{A}	2452 ± 764^{A}	2859 ± 765^{A}	2584 ± 763^{A}
PROTEIN (GM)	107 ± 28^{A}	98 ± 29^{A}	109 ± 27^{A}	105 ± 26^{A}
FAT (GM)	124 ± 37^{A}	112 ± 42^{A}	126 ± 37^{A}	110 ± 33^{A}
CARBOHYDRATE (GM)	276 ± 89^{A}	242 ± 83^{A}	294 ± 99^{A}	259 ± 92^{A}
ALCOHOL (GM)	13 ± 24^{A}	15 ± 18^{A}	13 ± 18^{A}	23 ± 27^{A}
CRUDE FIBER (GM)	3.6 ± 1.7^{A}	3.4 ± 1.6^{A}	3.5 ± 1.3^{A}	3.3 ± 1.4^{A}
CHOLESTEROL (MG)	589 ± 234^{B}	473 ± 199^{A}	600 ± 198^{B}	435 ± 152^{A}
CALCIUM (MG)	1051 ± 434^{A}	864 ± 352^{A}	1060 ± 383^{A}	978 ± 444^{A}
PHOSPHORUS (MG)	1698 ± 472^{A}	1541 ± 443^{A}	1743 ± 447^{A}	1720 ± 528^{A}
MAGNESIUM (MG)[2]	304 ± 127^{B}	231 ± 90^{A}	290 ± 88^{B}	221 ± 61^{A}
SODIUM (MG)	3480 ± 1317^{A}	3359 ± 1036^{A}	3582 ± 1117^{A}	3377 ± 1015^{A}
POTASSIUM (MG)	3023 ± 874^{A}	2840 ± 997^{A}	3000 ± 797^{A}	3040 ± 949^{A}
IRON (MG)	16.4 ± 5.1^{A}	16.7 ± 5.1^{A}	16.1 ± 3.9^{A}	16.7 ± 3.9^{A}
ZINC (MG)[2]	16.1 ± 5.2^{B}	13.2 ± 4.9^{A}	16.0 ± 4.7^{B}	14.7 ± 4.5^{AB}
COPPER (MG)[2]	1.62 ± 0.79^{A}	1.30 ± 0.72^{A}	1.51 ± 0.55^{A}	1.27 ± 0.60^{A}
MANGANESE (MG)[2]	1.62 ± 0.80^{A}	1.64 ± 0.75^{A}	1.78 ± 0.82^{A}	1.72 ± 0.90^{A}

[1]Values are Mean ± S.D. Underlined values are below the military nutritional standard. Values, within a row, not followed by a common letter are significantly different at $P<0.05$.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 13B

AVERAGE TOTAL DAILY NUTRIENT INTAKE[1]

COMRATS-MALES

	C&E and H&S PERSONNEL		FORCE TROOPS PERSONNEL	
	Phase I	Phase II	Phase I	Phase II
VITAMIN A (IU)	5064 ± 4531^{A}	5483 ± 7655^{A}	4690 ± 2934^{A}	4671 ± 5389^{A}
VITAMIN C (MG)	93 ± 68^{A}	77 ± 97^{A}	79 ± 43^{A}	81 ± 57^{A}
THIAMIN (MG)	1.45 ± 0.47^{A}	1.34 ± 0.53^{A}	1.50 ± 0.52^{A}	1.25 ± 0.38^{A}
RIBOFLAVIN (MG)	2.12 ± 0.75^{A}	1.91 ± 0.83^{A}	2.16 ± 0.55^{A}	2.09 ± 0.73^{A}
NIACIN (MG)	23.7 ± 7.5^{A}	23.5 ± 8.0^{A}	23.7 ± 7.6^{A}	23.8 ± 6.3^{A}
VITAMIN B-6 (MG)[2]	1.58 ± 0.54^{A}	1.21 ± 0.40^{B}	1.55 ± 0.60^{A}	1.50 ± 0.59^{A}
FOLIC ACID (MCG)[2]	215 ± 114^{B}	158 ± 67^{A}	199 ± 65^{B}	155 ± 76^{A}
VITAMIN B-12 (MCG)[2]	5.78 ± 6.84^{A}	5.63 ± 11.10^{A}	5.36 ± 4.90^{A}	4.90 ± 7.14^{A}
PANTOTHENIC ACID (MG)[2]	5.0 ± 2.6^{B}	3.6 ± 1.6^{A}	4.5 ± 1.4^{B}	3.6 ± 1.5^{A}

[1]Values are Mean ± S.D. Underlined values are below the military nutritional standard. Values within a row not followed by a common letter are significantly different at $P<0.05$.

[2]Food nutrient analysis data are limited for nutrient.

TABLE 14A
THREE-BY-TWO FACTOR ANALYSIS OF COVARIANCE
OF TOTAL DAILY NUTRIENT INTAKE DATA[1]

	FACTORS		COVARIATES	
	GROUP[2]	STUDY PHASE[3]	AGE	WEIGHT
QUANTITY	.000	NS[4]	NS	NS
ENERGY	.000	.001	.044	NS
PROTEIN	.000	.019	NS	NS
FAT	.000	.000	NS	NS
CARBOHYDRATE	.000	.011	.006	NS
ALCOHOL	.000	NS	NS	NS
CRUDE FIBER	.000	NS	NS	NS
CHOLESTEROL	.000	.000	NS	NS
ANIMAL PROTEIN	.000	.005	NS	NS
PLANT PROTEIN	.000	NS	NS	NS
ANIMAL FAT	.000	.000	NS	NS
PLANT FAT	.000	.050	NS	NS
FISH FAT	NS	NS	NS	NS

[1]Values indicate are P values.
[2]Group = RIK-Males, RIK-Females, or COMRATS-Males.
[3]Study Phase = 1977 or 1978.
[4]NS = Not significant at P<0.05.

TABLE 14B
THREE-BY-TWO FACTOR ANALYSIS OF COVARIANCE
OF TOTAL DAILY NUTRIENT INTAKE DATA[1]

	FACTORS		COVARIATES	
	GROUP[2]	STUDY PHASE[3]	AGE	WEIGHT
CALCIUM	.000	.001	.000	NS
PHOSPHORUS	.000	.012	.015	NS
MAGNESIUM	.000	.000	.028	NS
SODIUM	.000	NS	.004	NS
POTASSIUM	.000	.020	NS	NS
IRON	.000	.026	NS	NS
ZINC	.000	.000	NS	NS
COPPER	.000	.000	NS	NS
MANGANESE	.000	NS	.047	NS
VITAMIN A	.030	NS	NS	NS
VITAMIN C	.019	NS	NS	NS
THIAMIN	.000	NS	NS	NS
RIBOFLAVIN	.000	.004	.010	NS
NIACIN	.000	NS	.011	NS
VITAMIN B-6	.000	.000	NS	NS
FOLIC ACID	.000	.000	NS	NS
VITAMIN B-12	.010	NS	NS	NS
PANTOTHENIC ACID	.000	.000	NS	NS

[1]Values indicated are P - values.
[2]GROUP = RIK-Males, RIK-Females, or COMRATS-Males.
[3]STUDY PHASE = 1977 or 1978.
[4]NS = Not significant at $P<0.05$.

TABLE 15
U.S. HANES DIETARY INTAKE DATA (1971 - 1974)

	MALE	FEMALE
ENERGY (Kcal)	2888 ± 1155	1691 ± 756
PROTEIN (gm)	110 ± 51	65 ± 34
CALCIUM (mg)	1112 ± 850	682 ± 494
IRON (mg)	16.5 ± 7.6	10.0 ± 5.4
VITAMIN A (IU)	5305 ± 6933	3761 ± 4777
VITAMIN C (mg)	180 ± 128	85 ± 160
THIAMIN (mg)	1.74 ± 0.99	1.12 ± 0.82
RIBOFLAVIN (mg)	2.54 ± 1.49	1.53 ± 0.88
NIACIN (mg)	24.6 ± 12.5	13.6 ± 7.9
SODIUM (mg)	3032	1863
CHOLESTEROL (mg)	521	311

[1]Data from U.S. Health and Nutrition Examination Survey. Values are Mean ± S.D. for ages 20-24 years except sodium and cholesterol which are mean values for ages 18-44 years.

TABLE 16
AVERAGE DAILY SUCROSE AND TOTAL SUGAR CONSUMPTION

	Grams of Sucrose		Grams Of Total Sugar	
	Mean ± SD	Maximum	Mean ± SD	Maximum
PHASE I				
RIK-MALE	70 ± 42	194	114 ± 58	283
RIK-FEMALE	72 ± 47	174	106 ± 59	247
COM-MALE	63 ± 49	262	101 ± 64	390
PHASE II				
RIK-MALE	72 ± 54	270	137 ± 64	324
RIK-FEMALE	60 ± 34	139	111 ± 43	184
COM-MALE	53 ± 36	198	100 ± 51	231

TABLE 17
AVERAGE DAILY CALORIC COMPOSITION[1]

	Phase I	Phase II
PROTEIN KCAL (%)		
RIK-Males	14.1 ± 2.6A	14.6 ± 2.4A
RIK-Females	14.4 ± 3.2A	14.6 ± 3.1A
COMRATS-Males	15.7 ± 2.6B	16.5 ± 3.1B
FAT KCAL (%)		
RIK-Males	37.9 ± 6.8A	37.9 ± 6.2A
RIK-Females	40.0 ± 5.9A	37.7 ± 6.9A
COMRATS-Males	40.5 ± 5.5A	39.9 ± 5.6A
CARBOHYDRATE KCAL (%)		
RIK-Males	40.9 ± 5.8A	42.1 ± 7.5A
RIK-Females	43.9 ± 7.0A	45.5 ± 8.3B
COMRATS-Males	40.6 ± 7.0A	39.6 ± 6.6A
ALCOHOL KCAL (%)		
RIK-Males	6.5 ± 7.6B	6.4 ± 7.8B
RIK-Females	2.3 ± 3.8A	3.1 ± 3.8A
COMRATS-Males	3.1 ± 4.1A	4.7 ± 5.2AB

[1]Values are mean ± standard deviation. No significant differences between 1977 and 1978 data were found. Within a column, values not followed by a common letter are significantly different at $P<0.05$.

TABLE 18
THREE-BY-TWO FACTOR ANALYSIS OF VARIANCE OF MEALS PER DAY AND SOURCES OF TOTAL DAILY ENERGY

	GROUP[1] (P-Value)	STUDY PHASE[2] (P-Value)
% PROTEIN KCAL	.000	NS[3]
% FAT KCAL	.001	NS
% CARBOHYDRATE KCAL	.000	NS
% ALCOHOL KCAL	.000	NS
% KCAL FROM SNACKS	.005	.000
% KCAL FROM DINING HALL	.000	NS
% KCAL FROM HOME	.000	.000
% KCAL FROM RESTAURANTS	.000	.002
% KCAL FROM VENDORS	.000	.000
TOTAL MEALS/DAY	.002	.000

[1]GROUP = RIK-MALES, RIK-FEMALES, or COMRATS-MALES.
[2]STUDY PHASE = 1977 or 1978.
[3]NS = Not significant at $P<0.05$.

TABLE 19
AVERAGE DAILY NUTRIENT DENSITY INTAKE[1]
RIK-MALES

	Phase I	Phase II
PROTEIN (g)	35.3 ± 6.4	36.6 ± 6.1
CALCIUM (mg)	412 ± 139	403 ± 139
PHOSPHORUS (mg)	627 ± 103	642 ± 112
MAGNESIUM (mg)[2]	99 ± 27*	76 ± 20*
IRON (mg)	5.0 ± 1.0*	6.0 ± 1.0*
ZINC (mg)[2]	5.1 ± 1.2	4.9 ± 1.4
COPPER (mg)[2]	0.54 ± 0.21*	0.43 ± 0.14*
MANGANESE (mg)[2]	0.44 ± 0.17	0.45 ± 0.21
VITAMIN A (iu)	1543 ± 1187	1387 ± 1293
VITAMIN C (mg)	30 ± 16	36 ± 30
THIAMIN (mg)	0.47 ± 0.10	0.51 ± 0.14
RIBOFLAVIN (mg)	0.81 ± 0.19	0.80 ± 0.21
NIACIN (mg)	7.9 ± 1.9	7.7 ± 1.5
VITAMIN B-6 (mg)[2]	0.60 ± 0.18	0.55 ± 0.18
FOLIC ACID (mcg)[2]	59 ± 22*	49 ± 21*
VITAMIN B-12 (mcg)[2]	1.87 ± 1.83	1.61 ± 1.72
PANTOTHENIC ACID (mg)[2]	1.7 ± 0.6*	1.4 ± 0.5*

[1]Values are Mean ± S.D. Underlined values are below military nutritional standard expressed on a nutrient density basis. Values followed by an asterick are significantly different at P<0.05.

[2]Food nutrient analysis information is limited for nutrient.

TABLE 20
AVERAGE DAILY NUTRIENT DENSITY INTAKE[1]
RIK-FEMALES

	Phase I	Phase II
PROTEIN (g)	36.0 ± 8.1	36.4 ± 7.7
CALCIUM (mg)	455 ± 197	383 ± 141
PHOSPHORUS (mg)	629 ± 146	610 ± 139
MAGNESIUM (mg)[2]	<u>96</u> ± 24	<u>85</u> ± 34
IRON (mg)	<u>5.2</u> ± 1.1*	<u>6.6</u> ± 1.7*
ZINC (mg)[2]	<u>5.1</u> ± 1.3	<u>4.7</u> ± 1.8
COPPER (mg)[2]	0.44 ± 0.15	0.44 ± 0.20
MANGANESE (mg)[2]	0.53 ± 0.31	0.54 ± 0.40
VITAMIN A (iu)	<u>2034</u> ± 1770	<u>1656</u> ± 2991
VITAMIN C (mg)	41 ± 32	39 ± 31
THIAMIN (mg)	0.46 ± 0.10	0.50 ± 0.16
RIBOFLAVIN (mg)	0.77 ± 0.27	0.70 ± 0.22
NIACIN (mg)	6.9 ± 1.8*	8.1 ± 3.0*
VITAMIN B-6 (mg)[2]	<u>0.47</u> ± 0.14	<u>0.42</u> ± 0.21
FOLIC ACID (mcg)[2]	<u>73</u> ± 34*	<u>56</u> ± 44*
VITAMIN B-12 (mcg)[2]	1.97 ± 2.34	<u>1.22</u> ± 0.71
PANTOTHENIC ACID (mg)[2]	1.6 ± 0.6	1.4 ± 1.0

[1]Values are Mean ± S.D. Underlined values are below military nutrient standard expressed on a nutrient density basis. Values followed by an asterick are significantly different at P<0.05.

[2]Food nutrient analysis information is limited for nutrient.

TABLE 21
AVERAGE DAILY NUTRIENT DENSITY INTAKE[1]
COMRATS-MALES

	Phase I	Phase II
PROTEIN (g)	39.4 ± 6.4	41.2 ± 7.7
CALCIUM (mg)	384 ± 134	368 ± 127
PHOSPHORUS (mg)	624 ± 99	653 ± 104
MAGNESIUM (mg)[2]	107 ± 29	94 ± 28
IRON (mg)	5.9 ± 1.0*	6.8 ± 1.3*
ZINC (mg)[2]	5.9 ± 1.5	5.6 ± 1.5
COPPER (mg)[2]	0.57 ± 0.21	0.52 ± 0.20
MANGANESE (mg)[2]	0.62 ± 0.28*	0.69 ± 0.34*
VITAMIN A (iu)	1807 ± 1472	2068 ± 2385
VITAMIN C (mg)	32 ± 25	31 ± 30
THIAMIN (mg)	0.53 ± 0.12	0.53 ± 0.13
RIBOFLAVIN (mg)	0.78 ± 0.20	0.79 ± 0.20
NIACIN (mg)	8.6 ± 1.9*	9.7 ± 2.5*
VITAMIN B-6 (mg)[2]	0.57 ± 0.18	0.54 ± 0.15
FOLIC ACID (mcg)[2]	75 ± 32*	64 ± 24*
VITAMIN B-12 (mcg)[2]	2.14 ± 2.49	2.06 ± 3.26
PANTOTHENIC ACID (mg)[2]	1.7 ± 0.7*	1.4 ± 0.5*

[1]Values are Mean ± S.D. Underlined values are below military nutritional standard expressed on a nutrient density basis. Values followed by an asterick are significantly different at P<0.05.

[2]Food nutrient analysis information is limited for nutrient.

TABLE 22
THREE-BY-TWO FACTOR ANALYSIS OF
VARIANCE OF AVERAGE DAILY NUTRIENT DENSITY

NUTRIENT	GROUP[1] (P-Value)	STUDY PHASE[2] (P-Value)
PROTEIN	.000	NS[3]
CALCIUM	.022	.022
PHOSPHORUS	NS	NS
MAGNESIUM	.000	.000
IRON	.000	.000
ZINC	.000	NS
COPPER	.000	.003
MANGANESE	.000	NS
VITAMIN A	.017	NS
VITAMIN C	.046	NS
THIAMIN	.001	NS
RIBOFLAVIN	.044	NS
NIACIN	.000	.001
VITAMIN B-6	.000	.010
FOLIC ACID	.000	.000
VITAMIN B-12	NS	NS
PANTOTHENIC ACID	NS	.000

[1]Group: RIK-Males, RIK-Females, or COMRATS-Males.
[2]Study Phase: 1977 or1978.
[3]NS=Not significant at $P<0.05$.

TABLE 23
MALE PERSONNEL HEMOGLOBIN, HEMATOCRIT, AND SERUM FOLACIN, COPPER, AND ZINC LEVELS

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	76	17	143
Hemoglobin (g/dl)						
Mean ± SD	17.0 ± 1.1	17.3 ± 1.0	17.3 ± 1.1	16.9 ± 1.8	17.0 ± 0.9	16.9 ± 1.0
At risk (%)	0.8	0	0	2.6	0	0
Hematocrit (%)						
Mean ± SD	47.7 ± 2.6	49.0 ± 2.4	48.0 ± 2.5	48.6 ± 2.9	49.2 ± 2.8	48.8 ± 2.8
At risk (%)	5.6	1.6	0.9	3.9	0	2.8
Serum folacin (ng/ml)						
Mean ± SD	5.0 ± 2.2	4.7 ± 1.8	5.5 ± 2.4	6.0 ± 3.3	6.7 ± 4.5	5.4 ± 2.4
At risk (%)	14.3	14.3	5.2	2.6	5.9	7.7
Red cell folacin (ng/ml)						
Mean ± SD	246 ± 75	238 ± 80	248 ± 93	257 ± 93	308 ± 132	249 ± 80
At risk (%)	8.3	11.1	7.8	3.9	0	6.3
Serum copper (ug/dl)						
Mean ± SD	95.9 ± 15.3	100.6 ± 18.5	94.6 ± 13.8	ND[1]	ND	ND
At risk (%)	9.8	7.9	4.3			
Serum zinc (ug/dl)						
Mean ± SD	108.7 ± 13.9	108.6 ± 17.6	109.6 ± 12.2	ND	ND	ND
At risk (%)	0	3.2	0			

[1]ND = Parameter was not determined.

TABLE 24
MALE PERSONNEL SERUM LIPID LEVELS

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	76	17	143
Serum triglycerides (mg/dl)						
Mean $\pm$ SD	139 $\pm$ 77	150 $\pm$ 102	131 $\pm$ 88	169 $\pm$ 107	131 $\pm$ 60	125 $\pm$ 74
At risk (%)	33.8	28.6	28.4	52.6	29.4	24.5
Serum total cholesterol (mg/dl)						
Mean $\pm$ SD	187 $\pm$ 34	191 $\pm$ 40	174 $\pm$ 33	183 $\pm$ 39	168 $\pm$ 26	165 $\pm$ 34
At risk (%)	22.6	28.6	11.2	23.7	0	7.7
Serum HDL cholesterol (mg/dl)						
Mean $\pm$ SD	ND	ND	ND	36.7 $\pm$ 8.8	39.3 $\pm$ 10.0	43.8 $\pm$ 10.5
At risk				24.3	23.5	4.9
Serum LDL cholesterol (mg/dl)						
Mean $\pm$ SD	ND	ND	ND	112 $\pm$ 36	103 $\pm$ 26	96 $\pm$ 31
At risk (%)				5.4	0	1.4
Cholesterol risk factor						
<½ average (%)	ND	ND	ND	12.2	17.7	34.5
½ to average (%)				40.5	52.9	49.3
Average to 2X average (%)				47.3	29.4	15.5
>2X average				0	0	0.7
Serum total lipids (mg/dl)						
Mean $\pm$ SD	608 $\pm$ 130	633 $\pm$ 180	577 $\pm$128	ND	ND	ND
At risk (%)	8.3	14.3	6.9			

TABLE 25
MALE PERSONNEL BLOOD VITAMIN VALUES

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	76	17	143
Serum vitamin A (ug/dl)						
Mean ± SD	43.4 ± 11.6	47.0 ± 18.3	44.2 ± 11.6	29.6 ± 10.1	31.8 ± 11.8	36.3 ± 12.9
At risk (%)	10.5	9.5	9.6	56.6	47.1	28.7
Serum carotene (ug/dl)						
Mean ± SD	ND	ND	ND	76.2 ± 33.3	64.4 ± 23.9	74.9 ± 24.4
Low (%)				11.8	17.6	4.2
EGOT activity (IU/ml cells)						
Mean ± SD	1.36 ± 0.24	1.30 ± 0.24	1.32 ± 0.19	ND	ND	ND
EGOT-PLP stimulation						
Mean ± SD (coefficient)	1.89 ± 0.16	1.84 ± 0.23	1.87 ± 0.14	ND	ND	ND
At risk (%)	20.3	14.3	14.7			
ETK-TPP stimulation (%)						
Mean ± SD	12.9 ± 3.0	13.0 ± 3.8	12.3 ± 2.8	ND	ND	ND
At risk (%)	19.5	20.6	12.1			
EGSSR-FAD stimulation						
Mean ± SD (coefficient)	1.35 ± 0.13	1.39 ± 0.17	1.33 ± 0.11	ND	ND	ND
At risk (%)	3.0	11.1	1.7			

TABLE 26
MALE PERSONNEL SERUM IRON, TIBC, IRON SATURATION, FERRITIN, B-12, AND VITAMIN C LEVELS

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	76	17	143
Serum iron (ug/dl)						
Mean ± SD	106 ± 37	111 ± 38	106 ± 36	100 ± 31	111 ± 38	107 ± 35
At risk (%)	2.3	1.6	1.7	5.3	0	2.1
Serum TIBC (ug/dl)						
Mean ± SD	348 ± 36	344 ± 37	361 ± 42	338 ± 38	343 ± 47	347 ± 41
Elevated (%)	3.8	1.6	10.4	5.3	5.9	11.2
Serum iron saturation (%)						
Mean ± SD	30.8 ± 11.2	32.5 ± 11.0	29.7 ± 9.9	29.9 ± 9.7	32.6 ± 10.2	31.2 ± 10.2
At risk (%)	2.3	1.6	4.3	2.6	0	2.8
Serum ferritin (ng/ml)						
Mean ± SD	81.7 ± 52.3	104.2 ± 79.3	63.4 ± 51.6	75.3 ± 46.5	85.0 ± 52.6	54.9 ± 36.3
At risk (%)	0.8	0	3.5	1.3	0	0.7
Serum vitamin B-12 (pg/ml)						
Mean ± SD	711 ± 230	696 ± 224	709 ± 189	ND	ND	ND
At risk (%)	0	0	0			
Serum vitamin C (mg/dl)						
Mean ± SD	1.11 ± 0.31	1.00 ± 0.38	1.10 ± 0.31	ND	ND	ND
At risk (%)	0	0	0			

TABLE 27
MALE PERSONNEL SERUM MAGNESIUM, PHOSPHORUS, AND CALCIUM LEVELS

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	...	...	...
Serum magnesium (mg/dl)						
Mean ± SD	2.05 ± 0.14	2.06 ± 0.14	2.06 ± 0.15	ND	ND	ND
Serum magnesium (meq/l)						
Mean ± SD	1.69 ± 0.11	1.70 ± 0.12	1.69 ± 0.12	ND	ND	ND
Abnormal (%)	0	0	0			
Serum phosphorus (mg/dl)						
Mean ± SD	4.27 ± 0.54	4.21 ± 0.64	4.46 ± 0.57	ND	ND	ND
Abnormal (%)	10.5	11.1	15.5			
Serum calcium (mg/dl)						
Mean ± SD	10.53 ± 0.42	10.47 ± 0.44	10.45 ± 0.42	ND	ND	ND
Serum calcium (meq/l)						
Mean ± SD	5.26 ± 0.21	5.23 ± 0.22	5.22 ± 0.21	ND	ND	ND
Elevated (%)	9.8	4.8	6.9			
Calcium X phosphorus						
Mean ± SD	45.0 ± 6.0	44.2 ± 7.0	46.7 ± 6.5	ND	ND	ND
Low product (%)	0.8	1.6	0			

TABLE 28 A

MALE PERSONNEL URINARY BIOCHEMICAL VALUES

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. Studied	133	63	115	69	15	127
Urinary thiamin (ug/g creatinine)						
Mean ± SD	288 ± 197	322 ± 317	336 ± 245	254 ± 243	231 ± 156	280 ± 563
At risk (%)	4.5	7.9	3.5	10.1	13.3	10.2
Urinary riboflavin (ug/g creatinine)						
Mean ± SD	467 ± 571	605 ± 1514	519 ± 386	368 ± 483	422 ± 475	350 ± 364
At risk (%)	3.8	7.9	3.5	10.1	6.7	10.2
Urinary free vitamin B_6 (mg/g creatinine)						
Mean ± SD	44.3 ± 27.0	50.8 ± 72.4	45.0 ± 25.9	73.9 ± 208	57.6 ± 29.5	77.9 ± 241
At risk (%)	12.0	9.5	7.8	2.9	0	1.6
Urinary specific gravity						
Mean ± SD	1.023 ± 0.006	1.022 ± 0.007	1.023 ± 0.007	ND	ND	ND
Elevated (%)	11.4	4.8	7.8			
Urine osmolality (mosmol/kg)						
Mean ± SD	862 ± 235	816 ± 246	867 ± 246	ND	ND	ND
Abnormal (%)	0	0	0			
Urinary phosphorus (mg/g creatinine)						
Mean ± SD	700 ± 209	654 ± 223	704 ± 213	ND	ND	ND
Elevated (%)	4.1	5.1	2.8			

TABLE 28 B
MALE PERSONNEL URINARY BIOCHEMICAL VALUES

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	124	59	108	...	...	...
Urinary sodium (g/g creatinine)						
Mean ± SD	1.65 ± 0.84	1.60 ± 0.88	1.89 ± 1.11	ND	ND	ND
Elevated (%)	4.8	3.4	11.1			
Urinary sodium (meq/g creatinine)						
Mean ± SD	71.7 ± 36.7	69.7 ± 38.4	82.3 ± 48.1	ND	ND	ND
Urinary potassium (g/g creatinine)						
Mean ± SD	0.77 ± 0.41	0.80 ± 0.38	0.93 ± 0.53	ND	ND	ND
Low (%)	6.5	3.4	3.7			
Urinary potassium (meq/g creatinine)						
Mean ± SD	19.7 ± 10.6	20.4 ± 9.8	23.7 ± 13.5	ND	ND	ND
Urinary magnesium (mg/g creatinine)						
Mean ± SD	62.3 ± 24.2	64.7 ± 30.9	71.3 ± 27.2	ND	ND	ND
Low (%)	5.7	16.7	3.7			
Urinary calcium (mg/g creatinine)						
Mean ± SD	82.9 ± 52.1	91.7 ± 63.0	110.1 ± 67.5	ND	ND	ND
Elevated (%)	3.3	8.5	9.3			
Low (%)	6.5	6.8	2.8			

TABLE 29 A
MALE PERSONNEL URINARY AND SERUM PROTEIN STATUS VALUES

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	...	...	...
Serum total proteins (g/dl)						
Mean ± SD	7.30 ± 0.38	7.34 ± 0.36	7.26 ± 0.32	ND	ND	ND
Elevated (%)	3.0	6.3	0.9			
Low (%)	0.8	1.6	2.6			
Serum albumin (g/dl)						
Mean ± SD	4.55 ± 0.28	4.49 ± 0.29	4.53 ± 0.26	ND	ND	ND
Low (%)	0	0	0			
Serum globulins (g/dl)						
Mean ± SD	2.75 ± 0.31	2.85 ± 0.39	2.73 ± 0.30	ND	ND	ND
Elevated (%)	1.5	4.8	0			
Albumin/globulin ratio						
Mean ± SD	1.68 ± 0.23	1.62 ± 0.31	1.68 ± 0.24	ND	ND	ND
Low (%)	0	0	0			
Urinary nitrogen (g/g creatinine)						
Mean ± SD	6.24 ± 1.49	6.14 ± 1.64	6.73 ± 1.67	ND	ND	ND
Urinary urea (g/g creatinine)						
Mean ± SD	5.66 ± 1.56	5.39 ± 1.65	6.15 ± 1.75	ND	ND	ND

TABLE 29 B
MALE PERSONNEL URINARY AND SERUM PROTEIN STATUS LEVELS

Parameter	Phase I			Phase II		
	Comrat Married	Comrat Single	Rations-in-kind	Comrat Married	Comrat Single	Rations-in-kind
No. studied	133	63	116	...	...	...
Serum albumin (% of proteins)						
Mean ± SD	62.4 ± 3.2	61.3 ± 4.1	62.5 ± 3.3	ND	ND	ND
Low (%)	0	1.6	0			
Serum globulins (% of proteins)						
Mean ± SD	37.6 ± 3.2	38.7 ± 4.1	37.5 ± 3.3	ND	ND	ND
Elevated (%)	0	1.6	0			
Serum a-1-globulins (% of proteins)						
Mean ± SD	2.44 ± 0.63	2.51 ± 0.42	2.43 ± 0.65	ND	ND	ND
Serum a-2-globulins (% of proteins)						
Mean ± SD	7.85 ± 1.51	7.96 ± 1.78	7.78 ± 1.53	ND	ND	ND
Serum b-globulins (% of proteins)						
Mean ± SD	11.61 ± 1.41	12.02 ± 1.56	11.78 ± 1.24	ND	ND	ND
Elevated (%)	3.0	6.3	0			
Serum g-globulins (% of proteins)						
Mean ± SD	15.71 ± 2.95	16.17 ± 3.20	15.55 ± 2.61	ND	ND	ND
Elevated (%)	1.5	4.8	0.9			

TABLE 30

FEMALE PERSONNEL HEMOGLOBIN, HEMATOCRIT, AND SERUM FOLACIN, COPPER, AND ZINC LEVELS

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Female	All Females	Rations-in-kind Female
No. studied	42	38	47	40
Hemoglobin (g/dl)				
Mean ± SD	14.9 ± 1.2	14.9 ± 1.2	14.7 ± 1.1	14.6 ± 1.2
At risk (%)	0	0	0	0
Hematocrit (%)				
Mean ± SD	41.0 ± 2.7	40.9 ± 2.7	42.2 ± 3.1	42.2 ± 3.1
At risk (%)	9.5	10.5	6.4	5.0
Serum folacin (ng/ml)				
Mean ± SD	5.9 ± 5.5	6.1 ± 5.7	5.6 ± 4.2	5.3 ± 3.1
At risk (%)	19.0	18.4	19.1	20.0
Red cell folacin (ng/ml)				
Mean ± SD	293 ± 117	295 ± 119	271 ± 121	253 ± 102
At risk (%)	2.4	0	2.1	2.5
Serum copper (ug/dl)				
Mean ± SD	114.1 ± 31.9	114.2 ± 32.4	ND	ND
Abnormal (%)	16.7	18.4		
Serum zinc (ug/dl)				
Mean ± SD	98.8 ± 12.4	97.7 ± 11.2	ND	ND
At risk (%)	7.1	7.9		

TABLE 31
FEMALE PERSONNEL SERUM LIPID LEVELS

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. studied	42	38	47	40
Serum triglycerides (mg/dl)				
Mean ± SD	88 ± 32	87 ± 32	87 ± 43	82 ± 40
At risk	7.1	7.9	10.6	7.5
Serum total cholesterol (mg/dl)				
Mean ± SD	179 ± 31	179 ± 31	169 ± 33	162 ± 28
At risk (%)	7.1	7.9	2.1	0
Serum HDL cholesterol (mg/dl)				
Mean ± SD	ND	ND	51.6 ± 13.2	51.7 ± 13.6
At risk			0	0
Serum LDL cholesterol (mg/dl)				
Mean ± SD	ND	ND	99.8 ± 23.8	94.4 ± 20.2
At risk (%)			0	0
Cholesterol risk factor				
<½ average (%)	ND	ND	57.4	65.0
½ to average (%)			36.2	32.5
Average to 2X average (%)			6.4	2.5
>2X average			0	0
Serum total lipids (mg/dl)				
Mean ± SD	549 ± 84	548 ± 87	ND	ND
At risk (%)	0	0		

TABLE 32
FEMALE PERSONNEL BLOOD VITAMIN VALUES

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. Studied	42	38	47	40
Serum vitamin A (ug/dl)				
Mean ± SD	36.4 ± 7.9	36.0 ± 8.2	22.9 ± 8.7	23.1 ± 8.9
At risk (%)	23.1	25.7	80.9	80.0
Serum carotene (ug/dl)				
Mean ± SD	ND	ND	56.4 ± 24.2	58.1 ± 24.0
Low (%)			23.4	22.5
EGOT activity (IU/ml cells)				
Mean ± SD	1.45 ± 0.32	1.43 ± 0.30	ND	ND
EGOT-PLP stimulation				
Mean ± SD (coefficient)	1.87 ± 0.18	1.89 ± 0.16	ND	ND
At risk (%)	21.4	21.1		
ETK-TPP stimulation (%)				
Mean ± SD	12.6 ± 3.0	13.1 ± 2.7	ND	ND
At risk (%)	16.7	18.4		
EGSSR-FAD stimulation				
Mean ± SD (coefficient)	1.37 ± 0.15	1.38 ± 0.15	ND	ND
At risk (%)	9.5	10.5		

TABLE 33
FEMALE PERSONNEL SERUM IRON, TIBC, IRON SATURATION, FERRITIN, B-12, AND VITAMIN C LEVELS

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. studied	42	38	47	40
Serum iron (ug/dl)				
Mean ± SD	103 ± 45	103 ± 44	92 ± 32	91 ± 33
At risk (%)	14.3	13.2	2.1	2.5
Serum TIBC (ug/dl)				
Mean ± SD	395 ± 63	395 ± 63	360 ± 53	356 ± 49
Elevated (%)	42.9	39.5	12.8	10.0
Serum iron saturation (%)				
Mean ± SD	26.6 ± 11.1	26.8 ± 11.2	26.0 ± 9.0	25.8 ± 9.0
At risk (%)	21.4	21.1	6.4	5.0
Serum ferritin (ng/ml)				
Mean ± SD	22.7 ± 19.8	22.4 ± 19.9	22.5 ± 18.6	22.6 ± 19.7
At risk (%)	26.2	28.9	19.1	20.0
Serum vitamin B-12 (pg/ml)				
Mean ± SD	735 ± 211	730 ± 220	ND	ND
At risk (%)	0	0		
Serum vitamin C (mg/dl)				
Mean ± SD	1.09 ± 0.28	1.09 ± 0.32	ND	ND
At risk (%)	0	0		

TABLE 34
FEMALE PERSONNEL SERUM MAGNESIUM, PHOSPHORUS, AND CALCIUM LEVELS

Parameter	Phase I		Phase II	
	All Females	Rations-in-Kind Females	All Females	Rations-in-Kind Females
No. Studied	42	38	...	...
Serum magnesium (mg/dl)				
Mean ± SD	2.01 ± 0.12	2.00 ± 0.12	ND	ND
Serum magnesium (meq/dl)				
Mean ± SD	1.65 ± 0.10	1.65 ± 0.10	ND	ND
Abnormal (%)	0	0		
Serum phosphorus (mg/dl)				
Mean ± SD	4.02 ± 0.61	4.04 ± 0.58	ND	ND
Abnormal (%)	11.9	10.5		
Serum calcium (mg/dl)				
Mean ± SD	10.19 ± 0.43	10.20 ± 0.43	ND	ND
Serum calcium (meq/dl)				
Mean ± SD	5.08 ± 0.21	5.09 ± 0.21	ND	ND
Elevated (%)	4.8	5.3		
Calcium X phosphorus				
Mean ± SD	40.6 ± 6.0	41.1 ± 5.6	ND	ND
Low product (%)	2.4	0		

TABLE 35 A
FEMALE PERSONNEL URINARY BIOCHEMICAL VALUES

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. studied	42	38	44	38
Urinary thiamin (ug/g creatinine)				
Mean ± SD	393 ± 428	400 ± 449	220 ± 161	207 ± 150
At risk (%)	11.9	13.2	11.4	13.2
Urinary riboflavin (ug/g creatinine)				
Mean ± SD	624 ± 660	634 ± 692	459 ± 538	386 ± 458
At risk (%)	9.5	10.5	9.5	10.5
Urinary free vitamin B_6 (ug/g creatinine)				
Mean ± SD	87.9 ± 98.4	87.1 ± 102.6	111.3 ± 253.8	116.8 ± 271.3
At risk (%)	7.1	7.9	2.2	2.5
Urinary specific gravity				
Mean ± SD	1.022 ± 0.005	1.022 ± 0.005	ND	ND
Elevated (%)	4.8	5.3		
Urine osmolality (mosmol/kg)				
Mean ± SD	806 ± 205	814 ± 200	ND	ND
Abnormal (%)	0	0		
Urinary phosphorus (mg/g creatinine)				
Mean ± SD	698 ± 229	715 ± 232	ND	ND
Elevated (%)	5.7	6.3		

TABLE 35 B
FEMALE PERSONNEL URINARY BIOCHEMICAL VALUES

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. studied	37	34	...	...
Urinary sodium (g/g creatinine)				
Mean ± SD	1.89 ± 1.03	1.93 ± 1.03	ND	ND
Elevated (%)	8.1	8.8		
Urinary sodium (meq/g creatinine)				
Mean ± SD	82.3 ± 44.7	83.8 ± 44.8	ND	ND
Urinary potassium (g/g creatinine)				
Mean ± SD	0.82 ± 0.42	0.78 ± 0.41	ND	ND
Low (%)	8.1	8.8		
Urinary potassium (meq/g creatinine)				
Mean ± SD	21.0 ± 10.9	20.0 ± 10.6	ND	ND
Urinary magnesium (mg/g creatinine)				
Mean ± SD	70.8 ± 45.3	75.0 ± 45.0	ND	ND
Low (%)	22.2	15.2		
Urinary calcium (mg/g creatinine)				
Mean ± SD	104.8 ± 78.5	112.0 ± 77.8	ND	ND
Elevated (%)	13.5	14.7		
Low (%)	5.4	2.9		

TABLE 36 A
FEMALE PERSONNEL URINARY AND SERUM PROTEIN STATUS VALUES

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. Studied	42	38	...	...
Serum total proteins (g/dl)				
Mean ± SD	7.19 ± 0.51	7.20 ± 0.53	ND	ND
Elevated (%)	2.4	2.6		
Low (%)	2.4	2.6		
Serum albumin (g/dl)				
Mean ± SD	4.25 ± 0.44	4.20 ± 0.43	ND	ND
Low (%)	0	0		
Serum globulin (g/dl)				
Mean ± SD	2.95 ± 0.57	3.01 ± 0.57	ND	ND
Elevated (%)	12.2	13.5		
Albumin/globulin ratio				
Mean ± SD	1.51 ± 0.36	1.46 ± 0.33	ND	ND
Low (%)	11.9	13.2		
Urinary nitrogen (g/g creatinine)				
Mean ± SD	6.43 ± 2.79	6.68 ± 2.79	ND	ND
Urinary urea (g/g creatinine)				
Mean ± SD	5.49 ± 2.37	5.70 ± 2.37	ND	ND

TABLE 36 B

FEMALE PERSONNEL URINARY AND SERUM PROTEIN STATUS VALUES

Parameter	Phase I		Phase II	
	All Females	Rations-in-kind Females	All Females	Rations-in-kind Females
No. studied	42	38	...	...
Serum albumin (% of proteins)				
Mean ± SD	59.3 ± 6.0	58.6 ± 5.8	ND	ND
Low (%)	9.5	5.3		
Serum globulins (% of proteins)				
Mean ± SD	40.7 ± 6.0	41.4 ± 5.8	ND	ND
Elevated (%)	11.9	13.2		
Serum a-1-globulins (% of proteins)				
Mean ± SD	2.56 ± 0.82	2.60 ± 0.82	ND	ND
Serum a-2-globulins (% of proteins)				
Mean ± SD	8.53 ± 1.85	8.69 ± 1.85	ND	ND
Serum b-globulins (% of proteins)				
Mean ± SD	12.80 ± 1.76	12.91 ± 1.73	ND	ND
Elevated (%)	11.9	13.2		
Serum g-globulins (% of proteins)				
Mean ± SD	16.84 ± 4.75	17.24 ± 4.80	ND	ND
Elevated (%)	7.1	7.9		

TABLE 37 A
GUIDELINES USED TO EVALUATE THE BIOCHEMICAL DATA

Parameter	Male			Female		
	Deficient	At Risk	Acceptable (or normal range)	Deficient	At Risk	Acceptable (or normal range)
Hemoglobin (g/dl)	<12	<14	≥14	<10	<12	≥12
Hematocrit (%)	<37	<44	≥44	<31	<38	≥38
Serum iron (ug/dl)		<50	≥50		<50	≥50
TIBC (ug/dl)			(250-410)			(250-410)
Iron saturation (%)		<15	≥15		<15	≥15
Serum ferritin (ng/ml)		<10	≥10		<10	≥10
Serum folacin (ng/ml)	≤3.0	<6.0	≥6.0	≤3.0	<6.0	≥6.0
Red cell folacin (ng/ml)	<140	<160	>160	<140	<160	≥160
Serum triglycerides (mg/dl)		≥150	<150		≥150	<150
Serum total cholesterol (mg/dl)			(115-215)			(120-240)
Serum HDL cholesterol (mg/dl)		<30	≥30		>35	≥35
Serum LDL cholesterol (mg/dl)		≥170	<170		≥170	<170
Cholesterol risk factor						
<½ average			<3.5			<3.3
½ to average			3.5-5.0			3.3-4.5
Average to 2X average			5.0-9.5			4.5-7.0
>2X average			>9.5			>7.0
Serum total lipids (mg/dl)			(340-800)			(340-800)

TABLE 37 B
GUIDELINES USED TO EVALUATE THE BIOCHEMICAL DATA

Parameter	Men and Women		
	Deficient	At Risk	Acceptable/Normal Range
EGOT-PLP stimulation coefficient		≥2.0	<2.0
EGOT activity (IU/ml cells)		≤1.1	>1.1
ETK-TPP stimulation (%)	>20	>15	<15
EGSSR-FAD stimulation coefficient	>1.40	>1.20	<1.20
Serum vitamin A (ug/dl)	<20	<30	≥30
Serum carotene (ug/dl)		<40	≥40
Serum vitamin C (mg/dl)	<0.20	<0.30	≥0.30
Serum vitamin B_{12} (pg/ml)	<150	<200	≥200
Serum copper (ug/dl)			(75-150)
Serum zinc (ug/dl)			(80-150)
Serum calcium (mg/dl)			(9-11)
Serum calcium (meq/l)			(4.5-5.5)
Serum phosphorus (mg/dl)			(3.0-5.0)
Calcium X phosphorus product		<30	≥30
Serum magnesium (mg/dl)			(1.52-2.74)
Serum magnesium (meq/l)			(1.25-2.25)

TABLE 37 C

GUIDELINES USED TO EVALUATE THE BIOCHEMICAL DATA

Parameter	Men and Women		
	Deficient	At Risk	Acceptable/Normal Range
Serum total proteins (g/dl)	<6.0	<6.5	$\geq$6.5
Serum total albumin (g/dl)	<2.8	<3.5	$\geq$3.5
Serum total globulins (g/dl)			(2.5-3.5)
Albumin/globulin ratio		<1.0	$\geq$1.0
Serum albumin (% of proteins)			(52-67)
Serum globulins (% of proteins)			(33-48)
Serum b -globulins (% of proteins)			(9-15)
Serum q-globulins (% of proteins)			(9-22)
Urinary thiamin (ug/g creatinine)	<27	<66	$\geq$66
Urinary riboflavin (ug/g creatinine)	<27	<80	$\geq$80
Urinary free vitamin B_6(ug/g creatinine)		<20	$\geq$20
Urinary sodium (g/g creatinine)		$\geq$3.5	<3.5
Urinary potassium (g/g creatinine)		<0.33	$\geq$0.33
Urinary calcium (mg/g creatinine)	<20	>200	$\leq$200
Urinary phosphorus (mg/g creatinine)		>1100	$\leq$1100
Urinary magnesium (mg/g creatinine)		<30	$\geq$30
Urine osmolality (mosmol/kg)			(38-1400)
Urinary specific gravity			(1.003-1.030)

TABLE 38 A

COMBINED MALE AND FEMALE PERSONNEL BIOCHEMICAL NUTRITIONAL STATUS INTERRELATIONSHIPS

Parameters	Phase I[1]			Phase II		
	n	r	P	n	r	P
Hemoglobin vs. hematocrit	354	0.842	0.00001	283	0.936	0.00001
TIBC vs. serum iron	353	0.106	0.0238	283	0.083	NS
Serum ferritin vs. hemoglobin	352	0.230	0.00001	ND	...	...
Serum ferritin vs. hematocrit	352	0.230	0.00001	ND	...	...
Serum ferritin vs. serum iron	352	0.134	0.006	ND	...	...
Serum ferritin vs. serum iron saturation	352	0.211	0.00003	ND	...	...
Serum ferritin vs. TIBC	352	-0.264	0.00001	ND	...	...
Serum ferritin vs. serum folacin	352	-0.009	NS	ND	...	...
Serum ferritin vs. red cell folacin	352	-0.046	NS	ND	...	...
Red cell folacin vs. serum folacin	352	0.441	0.00001	283	0.648	0.00001
Whole blood folacin vs. serum folacin	352	0.465	0.00001	283	0.654	0.00001
Serum triglycerides vs. age	ND	...	...	282	0.132	0.013
Serum total cholesterol vs. age	ND	...	...	282	0.289	0.00001
HDL cholesterol vs. age	ND	...	...	280	-0.173	0.0018
LDL cholesterol vs. age	ND	...	...	280	0.259	0.00001
Cholesterol risk factor vs. age	ND	...	...	280	0.345	0.00001

[1] n = number of personnel studied; r = correlation; P = significance of correlation.

TABLE 38 B
COMBINED MALE AND FEMALE BIOCHEMICAL NUTRITIONAL STATUS INTERRELATIONSHIPS

Parameters	Phase I[1]			Phase II		
	n	r	P	n	r	P
Urinary riboflavin vs. urinary thiamin	339	0.528	0.00001	241	0.372	0.00001
Urinary riboflavin vs. urinary vitamin B_6	342	0.270	0.00001	253	0.442	0.00001
Urinary thiamin vs. urinary vitamin B_6	339	0.353	0.00001	239	0.244	0.00007
Urinary sodium vs. urinary potassium	324	0.490	0.00001	ND	...	...
Serum triglycerides vs. serum cholesterol	346	0.301	0.00001	282	0.370	0.00001
Serum cholesterol vs. serum lipids	344	0.750	0.00001	ND	...	...
Serum triglycerides vs. HDL cholesterol	ND	...	...	279	-0.300	0.00001
Serum triglycerides vs. LDL cholesterol	ND	...	...	279	0.053	NS
Serum cholesterol vs. HDL cholesterol	ND	...	...	280	0.127	0.017
Serum cholesterol vs. LDL cholesterol	ND	...	...	280	0.874	0.00001
Serum alblumin vs. serum total proteins	349	0.468	0.00001	ND	...	...
Serum globulins vs. serum total proteins	349	0.588	0.00001	ND	...	...
Serum albumins vs. serum globulins	349	-0.393	0.00001	ND	...	...
Albumin/globulin ratio vs. serum proteins	351	-0.259	0.00001	ND	...	...
Serum calcium vs. serum phosphorus	354	0.069	NS	ND	...	...

1 n = number of personnel studied; r = correlation; P = significance of correlation.

TABLE 39
CORRELATIONS BETWEEN BIOCHEMICAL AND DIETARY MEASUREMENTS

Parameters	Males			Females		
	n	r	P	n	r	P
Urinary thiamin vs. dietary thiamin	504	0.18	0.00001	84	0.28	0.005
Urinary riboflavin vs. dietary riboflavin	504	0.60	0.00001	84	0.09	NS
Urinary free vitamin B_6 vs. dietary vitamin B_6	497	0.15	0.00032	86	0.69	0.00001
Urinary calcium vs. dietary calcium	276	0.16	0.003	36	0.28	0.049
Urinary phosphorus vs. dietary phosphorus	276	0.17	0.003	34	0.42	0.007
Urinary magnesium vs. dietary magnesium	277	0.17	0.002	35	0.05	NS
Urinary sodium vs. dietary sodium	277	0.0001	NS	36	0.29	0.043
Urinary potassium vs. dietary potassium	277	0.03	NS	36	0.25	NS

[1] n = number of personnel studied; r = correlation coefficient; P = significance of correlation.

TABLE 40

CORRELATIONS BETWEEN BIOCHEMICAL AND DIETARY MEASUREMENTS

Parameters	Males			Females		
	n	r	P	n	r	P
Serum vitamin A vs. dietary vitamin A	524	-0.06	NS	84	0.007	NS
Serum vitamin C vs. dietary vitamin C	294	0.31	0.00001	41	0.20	NS
Serum folate vs. dietary folate	526	0.23	0.00001	87	0.49	0.00001
RBC folate vs. dietary folate	526	0.20	0.00001	87	0.52	0.00001
Serum B_{12} vs. dietary vitamin B_{12}	297	-0.05	NS	41	0.17	NS
Serum cholesterol vs. dietary cholesterol	526	-0.01	NS	87	0.08	NS
Hemoglobin vs. dietary iron	526	-0.06	NS	87	-0.11	NS
Hematocrit vs. dietary iron	526	-0.05	NS	87	-0.23	NS
Serum iron vs. dietary iron	525	0.02	NS	87	-0.09	NS
Serum TIBC vs. dietary iron	525	0.002	NS	87	0.06	NS
Serum iron sturation vs. dietary iron	525	0.016	NS	87	-0.125	NS
Serum zinc vs. dietary zinc	295	0.02	NS	41	0.25	NS
Serum copper vs. dietary copper	295	0.08	NS	41	-0.16	NS
Serum magnesium vs. dietary magnesium	295	0.03	NS	41	-0.20	NS
EGOT activity vs. dietary vitamin B_6	294	0.06	NS	39	0.08	NS
EGOT-PLP stimulation vs. dietary vitamin B_6	293	-0.14	0.007	39	-0.15	NS
ETK-TPP stimulation vs. dietary thiamin	297	-0.03	NS	41	-0.01	NS
EGSSR-FAD stimulation vs. dietary riboflavin	297	-0.15	0.005	41	-0.24	NS

† n = number of personnel studied; r = correlation coefficient; P = significance of correlation.

TABLE 41

SERUM VITAMIN A LEVELS OF 29 PALMS PERSONNEL BY AVERAGE DAILY VITAMIN A CONSUMPTION

Average Vitamin A Intake (1U/Day)	Males				Females			
	PHASE I		PHASE II		PHASE I		PHASE II	
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n
Less than 500	49.6 ± 15.1	(5)	...	(0)	...	(0)	...	(0)
>500 - 1000	55.5 ± 13.7	(4)	30.8 ± 6.3	(8)	26.0 ± 1.4	(2)	21.7 ± 5.1	(3)
>1000 - 1500	43.2 ± 8.6	(12)	28.5 ± 12.8	(17)	41.0 ± 6.9	(3)	23.8 ± 6.5	(8)
>1500 - 2000	48.3 ± 12.2	(20)	32.4 ± 9.3	(24)	38.8 ± 8.6	(6)	23.4 ± 8.2	(11)
>2000 - 2500	47.6 ± 25.1	(28)	32.9 ± 11.4	(21)	27.5 ± 2.1	(2)	28.4 ± 18.8	(5)
>2500 - 3000	45.9 ± 10.1	(31)	35.6 ± 11.8	(25)	34.8 ± 4.5	(4)	25.2 ± 6.6	(5)
>3000 - 3500	44.5 ± 13.3	(30)	32.5 ± 11.3	(28)	33.2 ± 15.4	(4)	22.8 ± 4.8	(4)
>3500 - 4000	46.4 ± 11.6	(20)	36.1 ± 13.4	(17)	40.3 ± 1.2	(3)	15.0	(1)
>4000 - 4500	44.3 ± 13.4	(22)	32.6 ± 11.2	(18)	40.5 ± 13.4	(2)	...	(0)
>4500 - 5000	41.2 ± 9.4	(13)	34.1 ± 9.2	(15)	31.5 ± 0.7	(2)	20.0 ± 1.4	(2)
>5000	42.0 ± 11.0	(110)	33.8 ± 12.9	(56)	37.9 ± 5.1	(10)	16.6 ± 4.9	(7)

TABLE 42
AVERAGE DAILY VITAMIN A INTAKE OF MARINES BY SERUM VITAMIN A LEVELS

Serum Vitamin A (mcg/dl)	Males				Females			
	PHASE I		PHASE II		PHASE I		PHASE II	
	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n	Mean ± SD	n
Less than 10	...		...		...		5,619	(1)
>10 - 20	14,409 ± 17,906	(2)	5,992 ± 10,799	(19)	3,450	(1)	5,106 ± 8,690	(17)
>20 - 30	7,568 ± 6,385	(27)	5,099 ± 5,659	(73)	3,048 ± 3,303	(8)	3,412 + 3,223	(20)
>30 - 40	5,751 ± 4,897	(77)	3,533 ± 2,315	(73)	6,276 ± 7,286	(15)	1,860 ± 438	(7)
>40	5,061 ± 4,445	(189)	5,006 ± 4,898	(64)	5,007 ± 6,054	(14)	2,379	(1)

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